TABLE OF CONTENTS

The Development of the Great Lakes Steel Corporation By J. A. Clauss, Chief Engineer, Great Lakes Steel Corporation, Ecorse, Mich.....G L 3

George R. Fink, Official Host to Convention.....2---3

Official Program of A. I. & S. E. Convention and Iron and Steel Exposition.....4---5

Convention Committees..... 7

Officials Participating in Convention..... 8

List of Exhibitors—Iron and Steel Exposition.....14---15

Convention Inspection Trips..... 16

Steel Plant of the Ford Motor Company..... F 3

Sheet and Strip Steel for Deep Drawing—By Joseph Winlock, Chief Metallurgist, Edward G. Budd Manufacturing Company, Philadelphia, Pa..... 17

Gas Distribution at Ford Plant—By F. J. Harlow, Manager Industrial Division, Philgas Department, Phillips Petroleum Company, Detroit, Mich..... 18

Study of Blast Furnace Charging—By Gordon Fox, Vice President, Freyn Engineering Company, Chicago, Ill.... 19

Fuel Economy—By Martin J. Conway, Fuel Engineer, Lukens Steel Company, Coatesville, Pa..... 20

Trend in Refractories Application in the Steel Plant—By A. V. Leun, Refractory Engineer, Bethlehem Steel Company, Bethlehem, Pa..... 21

Recuperators for Continuous Slab Heating Furnaces—By W. H. Fitch, Manager, Recuperator Department, Carborundum Company, Perth Amboy, N. J..... 22

Heat Treating Alloy Bar Stock in Electric Furnaces—By Dr. Marcus A. Grossmann, Director of Research, Carnegie-Illinois Steel Corporation, Chicago, Ill..... 24

Automatic Control in Open Hearth Furnaces—By A. F. Spitzglass, Vice President, Republic Flow Meters Company, Chicago, Ill..... 25

Resistance Welding in Steel—By Walter Anderson, Vice President and Malcomb Clark, General Manager, Taylor Winfield Corporation, Warren, Ohio 27

Individual Motor Drives on Strip Mills—By F. E. Harrell, Assistant Chief Engineer, and W. R. Hough Experimental Engineer, Reliance Electric & Engineering Company, Cleveland, Ohio..... 28

Material Handling in Hot Strip Mills—By F. M. Gillies, Assistant General Superintendent, Inland Steel Company, Indiana Harbor, Indiana..... 29

Soaking Pit Operation—By P. M. Offill, Vice President, Amsler-Morton Company, Pittsburgh, Pa..... 31

Steel Products in the Electrical Industry—By O. A. Tilton, Industrial Engineering Department, General Electric Company, Schenectady, New York..... 32

Steel Plant Lubrication—By C. J. Klein, Chief Engineer, Weirton Steel Company, Weirton. West Virginia..... 33

Electrical Equipment for Hot Strip Mills—By L. A. Umansky, Industrial Engineering Department, General Electric Company, Schenectady, New York..... 34

Report of A. I. & S. E. Development Committee—By W. H. Burr, Electrical and Mechanical Superintendent, Lukens Steel Company, Coatesville, Pa..... 36

Bright Annealing and Normalizing Auto-Body Stock Steel in Electric Furnaces—By F. T. Hague, Manager DC Engineering Department and P. H. Brace, Manager, Metallurgical Department, Research Division, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa..... 47

Centralized Lubrication and Roll Cooling Systems—By T. J. Kauffield, Special Representative, DeLaval Separator Company, Pittsburgh, Pa..... 58

Items of Interest..... 61

Advertisers Index.....XII-XIII

VOL. XIII *Published Monthly by* NO. IX

ASSOCIATION OF IRON AND STEEL ENGINEERS

Entered as second class matter January 25th, 1924, at Pittsburgh, Pa., under the Act of March 3rd, 1879. - - Single Copy $2.00

Subscription price in U. S. & Canada.....$5.00 per year

Subscription price in foreign countries .....$7.50 per year

BRENT WILEY, Editor — JOHN KELLY, JR., Associate Editor — JAMES D. KELLY, Advertising Mgr.

INTELLIGENT

REPUBLIC - SMOOT INSTRUMENTS - CONTROLS For The Steel Industry

AUTOMATIC CONTROLS
A complete line of control equipment for the automatic control of steam pressure, combustion, furnace pressure, excess pressure, load distribution, etc. Furnished for all types of boilers, furnaces, coke ovens, gas producers, gas mixers and fuel firing equipment.

BUTTERFLY VALVES

TURBINE TYPE VALVES
Designed for regulating the pressure and flow of liquids and gases, including high pressure superheated steam.

ELECTRICAL FLOW METERS
For metering the flow of steam, water, gas, air, oil, brine, etc.

RECORDING THERMOMETERS
A remote reading gas expansion type thermometer with single or multiple pen recorders.

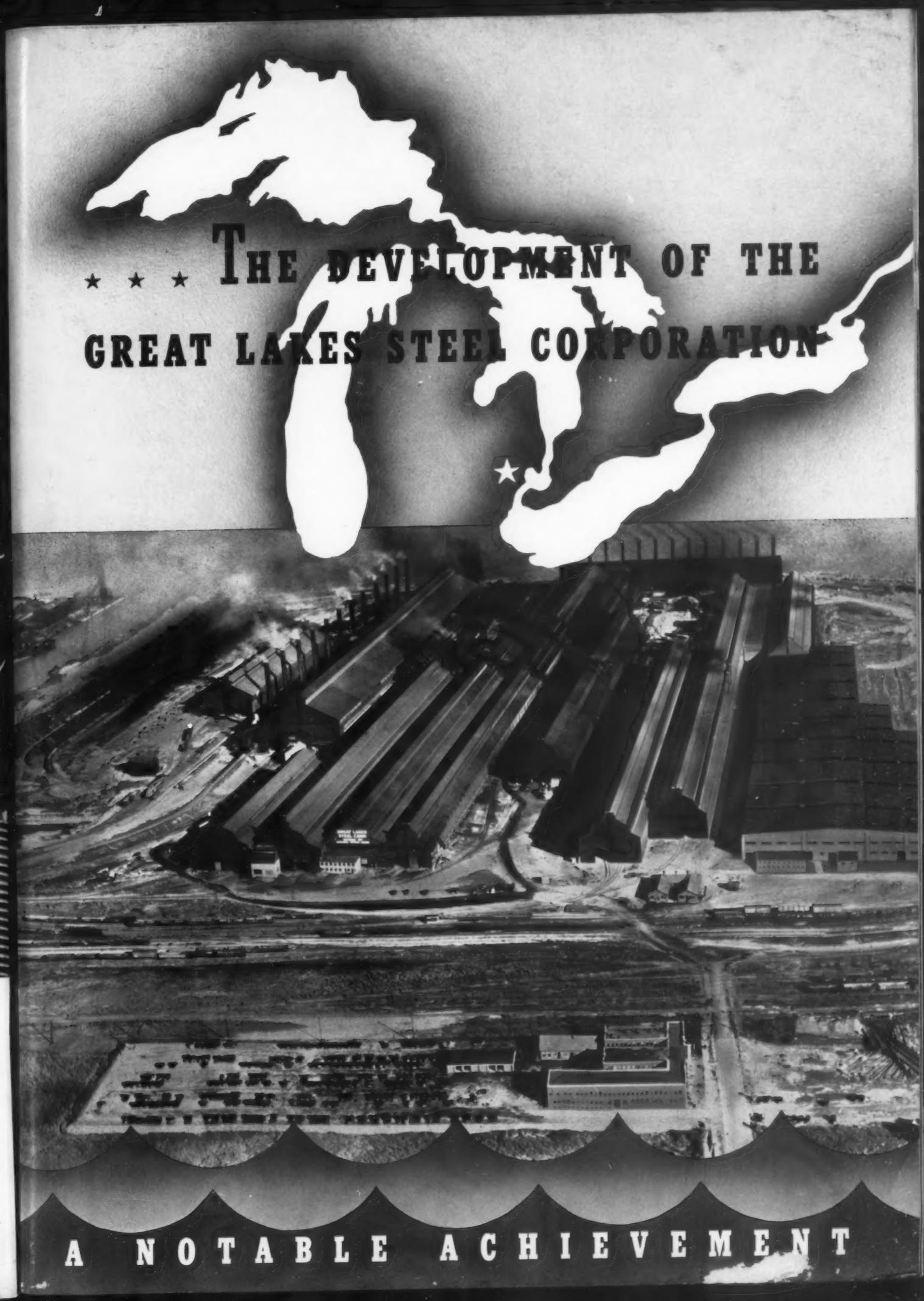
DRAFT INSTRUMENTS
Indicating or recording types in single or multiple units, including gages designed especially for steel mill applications.

CO_2 INSTRUMENTS
Provides a continuous record of percent CO_2 in flue gas measured by the Orsat method.

MASTER PANEL BOARDS
Designed and built for any combination of instruments and controls desired.

At the Iron and Steel Exposition, in Booths Nos. 145 and 146, we will exhibit, for your inspection and examination, the new Smoot panel type Furnace Pressure Controller—the Smoot Automatic Combustion Control System—the Republic Vacuum and Pressure Recorders for coke oven gas exhausters, collecting mains, furnaces, etc.,—the Republic super-sensitive Draft and Pressure Recorder with a full scale range of $\pm$ $^1/_{10}$ of an inch of water—and many other outstanding developments in the field of instruments and controls . . . Republic engineers will be glad to demonstrate and explain the operation of this equipment. This is your opportunity to examine these modern instruments and controls — designed to meet the special and exacting requirements of the iron and steel industry.

REPUBLIC FLOW METERS CO., Chicago, Ill.


★ ★ ★ THE DEVELOPMENT OF THE
GREAT LAKES STEEL CORPORATION
A NOTABLE ACHIEVEMENT

George R. Fink

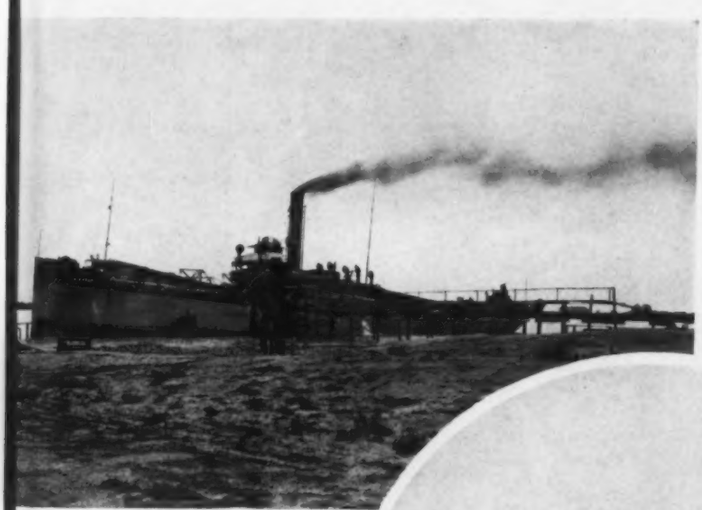
President

THE GREAT LAKES
STEEL CORPORATION

The Development of

THE GREAT LAKES STEEL CORPORATION

» » » By JULIUS A. CLAUSS, Chief Engineer



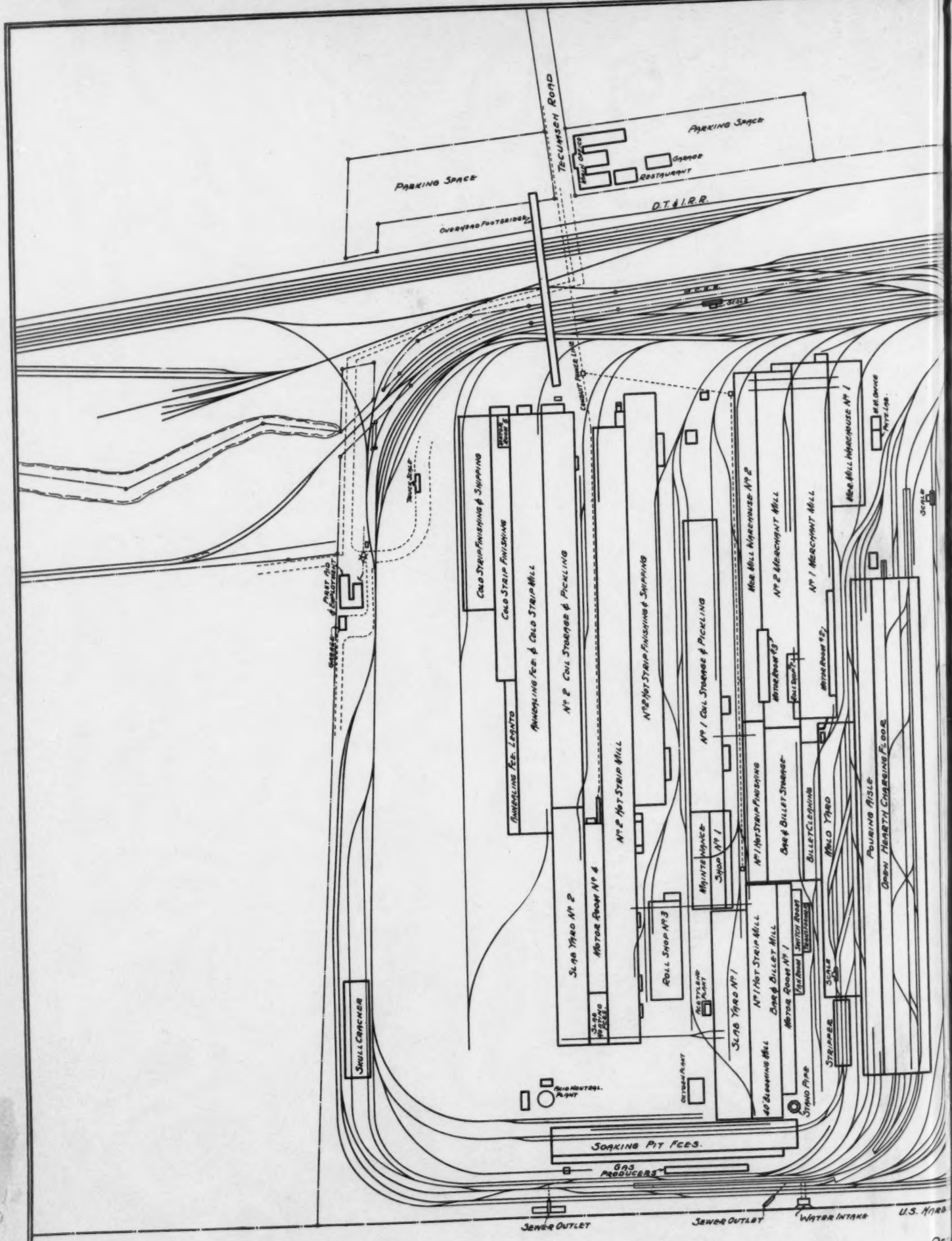
Here in brief is a pictorial story of the development of the Great Lakes Steel Corporation. The upper left and center photographs show how the original plant site was transformed from a marsh to a suitable area for erecting a steel plant. By means of these boats with special equipment, approximately 1,600,000 tons of sand for fill were brought to this site. The sand was hydraulically pumped from the boats to the marsh, a distance of 2500 feet. From this start and over a short span of years there evolved the largest strip mill in the world as depicted in the lower right illustration.

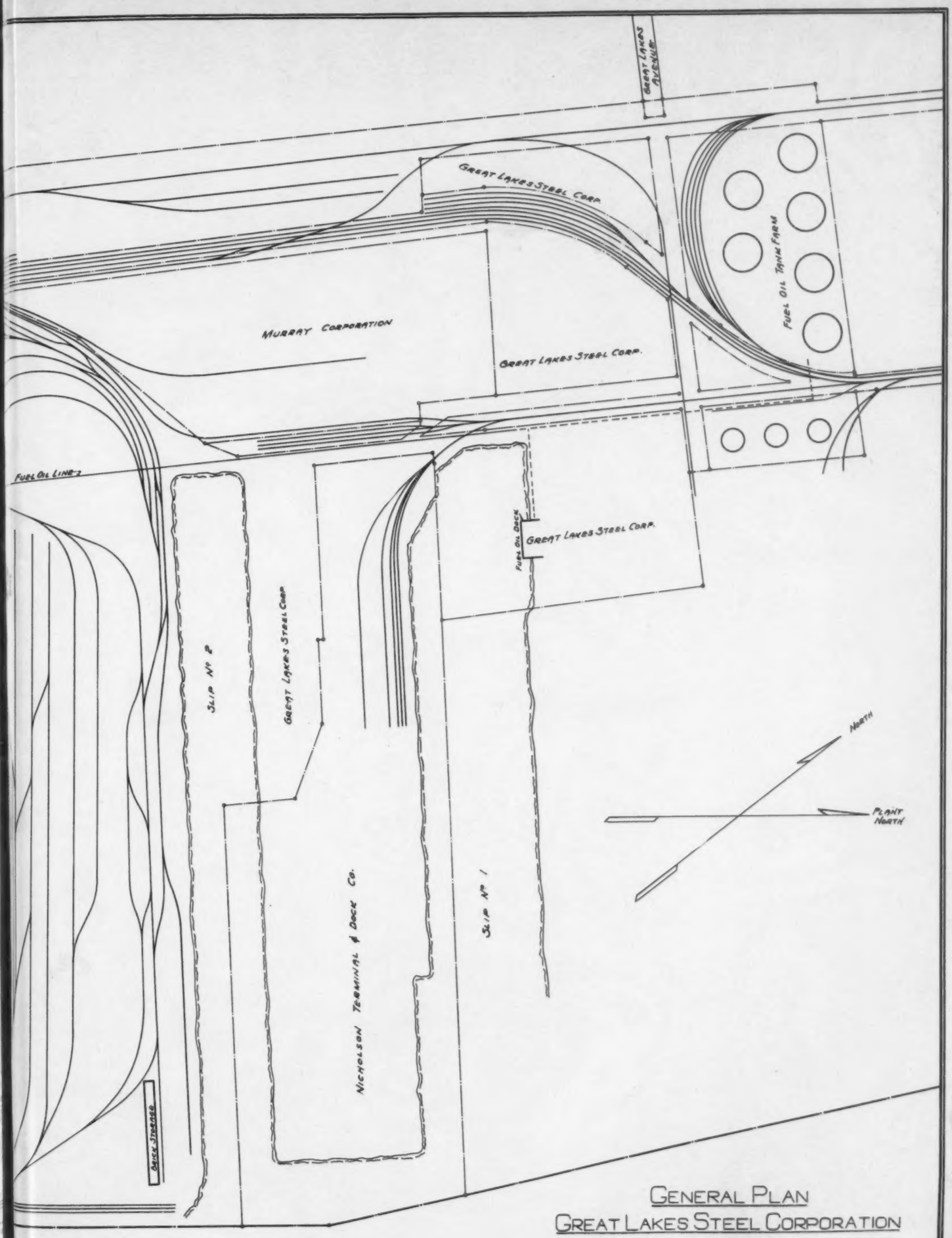
▲ THE PLANT of the Great Lakes Steel Corporation in the Village of Ecorse, Michigan, is bounded on the north by the properties of the Murray Corporation of America and the Nicholson Terminal and Dock Company, with a navigable slip or short canal between the Nicholson and Great Lakes properties; on the east by the Detroit River for a distance of approximately twenty-eight hundred feet; and on the south and west by the Michigan Central and Detroit, Toledo and Ironton railroads.

The area enclosed within these boundaries is almost square and contains about two hundred and twenty-five acres.

It will be noted that two sides of the property are surrounded by water and two sides are adjacent to railroads, thus providing opportunity for the receiving and shipping of materials, either by rail or water. The Detroit River is also a splendid source of supply for the large amount of service water required for steel plant operation.

(Continued on page 6)


TECUMSEH ROAD
PARKING SPACE
PARKING SPACE
OVERHEAD FOOTBRIDGE
D.T.&I.R.R.
W.C.R.R.
SCALE
CONDUIT POWER LINE
TRUCK DOCK
DEPT. FOR EMPLOYMENT
COLD STRIP FINISHING & SHIPPING
COLD STRIP FINISHING
ANNEALING FCE. & COLD STRIP MILL
ANNEALING FCE. LEGATO
No. 2 COIL STORAGE & PICKLING
No. 2 HOT STRIP FINISHING & SHIPPING
No. 2 HOT STRIP MILL
No. 1 COIL STORAGE & PICKLING
No. 2 MILL WAREHOUSE
No. 2 MERCHANT MILL
No. 1 MERCHANT MILL
No. 1 MILL WAREHOUSE
SLAB YARD No. 2
MOTOR ROOM No. 4
ROLL SHOP No. 3
MAINTENANCE SHOP No. 1
No. 1 HOT STRIP FINISHING
BOX & BILLET STORAGE
BILLET CLEANING
MILL YARD
POURING AISLE
OPEN HEARTH CHARGING FLOOR
SCALE
SKULL CRACKER
SLAB YARD No. 1
No. 1 HOT STRIP MILL
BOX & BILLET MILL
MOTOR ROOM No. 1
SWITCH ROOM
STRIPPER
SCALE
SOAKING PIT FCES.
GAS PRODUCERS
SEWER OUTLET
SEWER OUTLET
WATER INTAKE
U.S. NAVAL



GENERAL PLAN
GREAT LAKES STEEL CORPORATION
ECORSE, MICHIGAN

This site, while a marsh, was the only site in the Detroit switching area of sufficient size with the required rail and water connections for the steel plant it was desired to build. The site, being mostly under water, presented some natural difficulties. Before starting construction, test holes were drilled at various points, from the borings of which the nature of the ground was determined. Test piles were also driven to determine their penetration and load carrying capacity. Rock was found at approximately elevation 501.0′, which is about 88′ 0″ below the plant yard level. Holes were drilled into this rock at a number of places about 100 feet. It was also known that there were salt wells on part of the property which were drilled through rock some fifteen hundred feet.

As a firm foundation is a vital necessity for any important structure, it was decided that upon this rock the steel plant would be built.

Approximately 75,000 wood piles having an average length of 75 feet have been driven to rock; these piles are cut off below water level and capped with a heavy concrete mat. Until recently, only wood piles were used. As the plant site is gradually being filled to yard level and, where shallow foundations are possible, some concrete cast in place piles are now being used. This type of pile is also driven to rock. All of the main buildings and machinery foundations are supported on piles.

Equal in importance to a solid foundation was the necessity to avoid trouble due to high water from which so many of the older plants suffer today. Water in the flues of the open hearth furnaces, soaking pits, and heating furnaces has been a serious handicap in many installations. In order to bring the bottom of the furnace flues to a height which would eliminate all danger from high water, the natural ground elevation was raised about fifteen feet. This meant that a large amount of fill would be required quickly and cheaply. Since water was the source of our difficulty, water was used to help solve the problem.

By the use of boats with special equipment, approximately 1,600,000 cubic yards of sand were taken from the St. Clair flats and from Lake Erie near Pelee Island and transported to the site. These boats were anchored in the Detroit River and a connection made to a system of large pipes through which the sand was hydraulically pumped into the area to be filled. In addition to the sand fill, approximately 1,500,000 cubic yards of dry fill were required which was delivered to the site by railroad cars and motor trucks. By these means a waste marsh was converted into a usable industrial plant site.

LAYOUT OF PLANT

In order to locate the first units to be built so as to avoid interference with operations as the plant was extended, the ultimate plant was laid out. The whole layout was carefully studied, and the tracks so often neglected to the last and yet so important to successful operation were given special consideration, as well as the location and proper size of the sewers and service water mains. An extensive standard gauge railroad track system, containing about thirty miles of single line track, has been installed.

A unique feature of the plant is the manner in which the various units have been arranged. Operations are wholly progressive and mechanical. There is no backtracking. Raw materials are received at one end of the plant and there is no further outside transportation

DAVID THOMSON
Vice President in Charge of Operations

JULIUS A. CLAUSS
Chief Engineer

J. S. PASTORIUS
General Superintendent

ew of the first heat being tapped from No. 2 furnace on August 23, 1930. This was fifteen months after the starting of construction.

until the finished products are loaded for shipment in the finishing buildings.

The average visitor to a steel plant is impressed with the spectacular operation of an open hearth furnace, the massiveness of the mill machinery, or the size of the main driving motors.

The best furnaces and mill equipment, which could be built, would be of little use unless served by suitable auxiliary equipment. The total cost of the necessary auxiliaries required for a successful plant or mill installation is very much greater than the cost of the major items of furnaces and mills.

Buried and out of sight are the massive foundations which must be correctly designed to carry the heavy weight and shocks from the mill equipment. Also out of sight and seldom mentioned are elaborate systems for sewers, water and power distribution. Their correct design require an immense amount of detail engineering and their proper installation requires a great deal of careful and painstaking labor.

In the development of the Great Lakes Steel plant, the design and installation of the auxiliary equipment was given careful consideration so that, when the plant was extended, this equipment would be correctly located and of proper size and capacity.

A complete sewer system, containing about six miles of sewers, varying in size from 8 inches to 84 inches in diameter, has been installed.

A service water system, with lines varying in size from 6 inches in diameter to 42 inches in diameter and containing about eight miles of pipe, is arranged in a loop system so that water can be delivered from more than one direction to the major points of consumption.

Seven and one-half miles of pipe, varying in size from 3 inches to 12 inches, comprise a distribution system for steam, compressed air, and fuel oil.

Numerous other auxiliaries, such as offices and laboratories, maintenance shop, fuel oil storage, water intake and pump house, rolling stock, etc., were all developed and fitted into the general plant scheme so as to make an efficient arrangement which could be easily extended as future needs required without interference with regular plant operation.

Sufficient space was reserved between the slip extending along the northern boundary line and the open hearth group of buildings for a future blast furnace plant.

POWER SUPPLY

24,000 volt power is delivered by The Detroit Edison Company through a system of underground conduits carrying 5—10,000 kva., 24,000 volt, 3 phase, 60 cycle lines to 5—10,000 kva. transformers rated 24,000 to 6600 volts, 3 phase, 60 cycles. Three of the transformers are connected to No. 1 Substation and two to No. 4 Substation. Each transformer is connected to an individual bus section and the bus sections are tied together through a synchronous bus and 3% reactors. All oil switches are rated 15,000 volts, 500,000 kva.

The synchronizing buses of Stations Nos. 1 and 4 are connected by a 10,000 kva., 3 phase, 11,500 volt cable tie, run in the roof trusses of the mill buildings. This tie line consists of three 3-conductor cables, each in an iron conduit.

ORIGINAL INSTALLATION

First Unit Installed

The first installation at the Great Lakes Steel plant consisted of the following principal units:

6—150 ton open hearth furnaces, with stock house, mold yard, and one 200 ton stripper
4—Four hole soaking pits with gas producers
1—40″ blooming mill
1—27″, 24″ and 21″ bar and billet mill
1—30″ strip mill
1—14″ merchant mill
1—10″ merchant mill

also substations, pump house, finishing departments, maintenance shops, and a complete system of tracks, sewers, water lines, and power distribution system.

The first excavation for these units was made on May 25, 1929; the first piles driven June 28; the first concrete poured August 14; and the first steel columns erected October 28, 1929.

Fifteen months after the starting of construction, on August 23, 1930, the first heat of steel was tapped from No. 2 open hearth furnace. Two days later, on August 25, the first ingot was rolled in the blooming and bar and billet mills.

The first strip was rolled on September 2, 1930. The 14″ merchant mill was put into operation on March 13, 1931, and the 10″ merchant mill on July 24, 1931.

In 1933, two 150 ton open hearth furnaces and two 4-hole soaking pits were added.

In May 1935, construction was started for two soaking pits and the 96″ hot and cold strip mills. This hot strip mill was put into operation on March 23 and the cold mill on June 1, 1936.

Open Hearths

In February 1936, construction was started for four 150 ton open hearth furnaces and four soaking pits. These open hearth furnaces will be completed by October and will bring the total number of open hearth furnaces to twelve as originally planned. The twelve furnaces will have a capacity for an annual production of one and one-quarter million tons of steel.

The open hearth furnaces are housed in a suitable building with the necessary auxiliaries, such as boilers, cranes, ladles, charging cars, and ingot mold cars. These furnaces are fuel oil fired, having a hearth 16 feet wide by 48 feet long; they are well proportioned and heavily built. The experienced open hearth man, in viewing this unit, is struck with the completeness of the installation, its convenient arrangement, and the light and airy buildings housing the equipment.

As good steel is necessary for the quality of product rolled, nothing that experience and sound practice required was omitted in this furnace plant—the heart of our operations. Its successful operation from the very beginning has justified the care and expense incurred in its construction.

While this open hearth furnace plant has for the most part followed the conventional arrangement, it differs from the usual in that the furnaces are of larger capacity, spaced 110 feet centers, and are oil fired. The checkers are of more than ordinary depth and volume. Particular pains were taken in the construction of the flues which are of large cross-section with straight line direction and so arranged that the products of combustion can be passed through an 8 ft. by 160 ft. steel brick-lined stack or a 600 HP fire tube waste heat boiler. All of the steam required for the plant operations, such as heating of buildings, pickling, etc., is generated by these waste heat boilers. Two oil-fired standby boilers have been provided for emergency use.

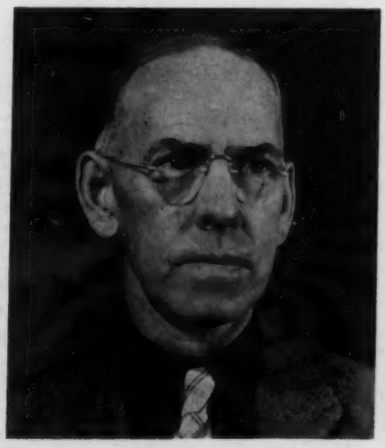
Since the production of steel was the primary object for building these open hearth furnaces, we believed that nothing should be done to prevent this being accomplished. And, notwithstanding the difference of opinion amongst open hearth furnace operators as to the value of waste heat boilers, it was our opinion that, properly installed, these boilers would be an aid rather than a handicap to the furnace operation. The boilers were designed to handle from 90,000 to 120,000 lbs. of waste gases per hour at a temperature of 1100 degrees F. and produce steam at 150 lbs. pressure, equal to about 500 boiler horsepower per hour.

An important item in any waste heat boiler installation, and the one to which most troubles in operation are due, is the mechanical draft equipment. On this installation the fans are of the double inlet steel plate type, and the inlet boxes are joined to the rear smoke box of each boiler by a short Wye connection. The fans discharge directly into the stacks through nozzles riveted to the lower cone sheets. Regulation of draft

E. M. DOIG
Budget Director

K. B. COATES
Assistant Treasurer

LACEY S. BROWN
Treasurer



J. W. IRWIN
Works Auditor

is obtained through variable speed control of the fan motors or turbines, there being a 2 to 1 speed variation. All parts of the waste heat boiler units are above the ground floor level and no part above the charging floor. The entire boiler installation is neat and compact, and the performance since starting operations has exceeded expectations.

Fuel Supply

While space has been allotted adjacent to the open hearth building for the installation of gas producers, should they be desired at any time in the future, oil was selected for the primary fuel. As there was no auxiliary fuel available, the design and arrangement of the fuel oil supply system was considered of prime importance, in order that no serious interruption in the fuel supply would be encountered and that the large amount of fuel oil would be economically distributed to the various heating units.

Oil can be delivered direct from boats, docked in one of the slips north of the property, through an 8-inch line to two 600,000 gal. storage tanks located close to the open hearth furnace plant, or through an extension of this line connecting to a fuel oil storage tank farm located about 2600 ft. north of the furnace plant.

The selection of the proper kind and size of fuel handling and conditioning equipment for a plant in the process of construction is, in itself, a difficult task. Assumptions must be made as to the nature of the fuel oils available and equipment must be selected of proper size to take care of future expansion and also to operate economically at the capacities required by the initial installation. With the exception of the soaking pits, all of the furnaces are oil fired. To provide for a continuous supply of fuel oil, a pipe line of ample size forms a continuous loop through the various departments.

Each heating unit throughout the plant has its own individual oil conditioning equipment, consisting of heaters, pumps, etc., conveniently located so that the pressure and temperature desired for that particular unit can be had without any dependence on other units.

In the main oil pumping station, located adjacent to the storage tanks, an extremely flexible oil conditioning system is installed consisting of strainers, pumps, and heaters of ample capacity for the present installation and so arranged that additional equipment can be easily added when required.

Each open hearth furnace has its own individual oil conditioning system supplied with oil from the main header. This permits each furnace to be furnished with that pressure and temperature of oil best suited for its operation. The arrangement of piping is such as to provide for a recirculation of approximately 33% of the oil pumped through the heaters. This recirculation of oil prevents the clogging of pipes about the unit and improves the temperature of the oil by keeping a continuous flow of oil through the heaters when the furnace burners are shut off for any cause. The temperature of the oil, which varies from 225 degrees to 300 degrees F., is automatically controlled. Steam driven reciprocating pumps of 500 gal. per hour capacity,

← H. D. FENSKE
Manager, Transportation Dept.

E. L. WETSTEIN
Vice President in Charge of Sales
↓

P. T. FARRELL
Purchasing Agent

G. G. GRIES
Vice President in Charge of Sales

General view of the No. 1 merchant mill with the cooling bed in the foreground.

delivering oil from 150 to 250 lbs. pressure per square inch, are used. The burner operating stands are located on the open hearth charging floor near the furnace door controls. In operation, the proper conditioning of the fuel oil has given most satisfactory results.

Parallel with and adjacent to the open hearth building are located, on one side, a suitable stock house for the raw products required for the open hearth furnaces and, on the other side, the ingot mold yard. East of and at the end of the mold yard is located the stripper building, in which are housed two 200 ton overhead electric stripper cranes and one inverted stripper.

All of the various building of the open hearth unit are equipped with suitable cranes varying in capacity from the 250 ton steel ladle crane to the 15 ton stock house cranes. Convenient movement of the materials in process was given careful consideration, with the result that there is a minimum of tracks, yet sufficient, for the continuous and efficient transportation of the large amount of raw materials.

Paralleling the open hearth unit are the rolling mills, with the soaking pit and gas producer buildings at the east end and at right angles to the mill building. Nine 10 ft. gas producers are used to furnish the fuel for the soaking pits. These producers are equipped with modern and efficient coal and ash handling equipment. There are twelve soaking pit furnaces having four holes each, each hole having a capacity for six large ingots. The arrangement of these furnaces differs from the usual in that they are at right angles to the mill, thus requiring a minimum of travel for the pit crane and ingot chariot.

Rolling Mills

While the making of steel in an open hearth furnace is always spectacular, and to the uninitiated a mysterious event, the very nature of the process which requires a well-defined type of equipment apparently limits the inventive mind of the mechanical engineer, and he, therefore, turns to the rolling mill with its immense amount of mechanical equipment as a more fertile field for his inventive efforts.

The developments and improvements during the past eight years in rolling mill equipment have been rapid and far reaching in their effect on old-established practice. To make the mechanical units of the modern rolling mill almost human in their action, the electrical engineer has played no small part; in fact, without his aid, the progress we have made would have been impossible.

Here, at the Great Lakes Steel rolling mills, you will find the last word in mechanical and electrical engineering; here you will find electricity used to its fullest extent in conjunction with the latest mechanical equipment. By the aid of electrical devices, a few men, almost unseen, control the entire operation.

The 40″ blooming mill, with its 7000 HP reversing motor, is a masterpiece of the designer's art; clean cut, well proportioned, speedy, and efficient, it reduces the large ingots into slabs or blooms in from 19 to 23 passes in about one minute. As the ingot passes through its rolls, it is shot between the side guards of the manipulators, which turn it from side to side. One is impressed with the massiveness of the design required to withstand the shocks and hard usage which the machinery is subjected to for the rapid reduction of the ingot to bloom or slab. Solid forged steel rolls, running in roller bearings carried in heavy cast steel girders, form the carrying medium for moving the material to and from the mill at a speed of from 350 to 400 feet per minute.

Bar and Billet Mill

When rolling sheet bars or billets, the bloom, after leaving the blooming mill and now about 6 inches by 8 inches in cross-section and about 60 feet long, is moved transversely about 35 feet to a roller table, which carries it to a cropping shear in front of the bar mill. After the end has been sheared off, it is ready to enter the first stand of a nine-mill unit, the rolls of which vary in diameter from 27 inches to 21 inches. The first seven stands of this roll train are equipped with motor-operated screwdowns, the last two stands being the conventional type with open top housings. The rolls of this mill run in the usual type of babbitt

and bronze bearings. The first four stands of this Mill are driven by a 4000 HP synchronous motor through a common gear drive, the next three stands by a 5000 HP synchronous motor through a common gear drive, and the last two stands have each a 2000 HP, 600 volt, D.C., variable speed motor. Two vertical edging mills are also in the train, one located between the third and fourth stands and the other between the sixth and seventh stands, each driven by a 250 HP motor. The mills vary in speed from 89 feet per minute for the first stand to slightly more than 900 feet for the last stand.

As the material leaves the last stand of this mill it is cut into the proper lengths by a rotary shear and then conveyed by a motor roller table to the sheet bar piler or the billet cooling beds which are located some 325 feet from the finishing mill in the bar and billet storage yard.

38" Hot Strip Mill

When the blooming mill is rolling slabs, they can be either rolled direct into strip or, after being sheared into lengths, can be moved over a slab cooling bed and discharged into the slab storage yard, which is parallel with the blooming mill. From this slab yard, the slabs can be charged into the strip mill heating furnaces, of which there are two, each having a capacity for heating 40 tons of slabs per hour. In heating these slabs they are slowly pushed through the furnace, and discharged onto a roller table which is a continuation of the blooming mill tables and conveyed to the strip mill.

The first stand of this mill is about 390 feet from the blooming mill, and the centerline of the strip mill is approximately in line with the centerline of the blooming mill, thus permitting, when desired, the direct delivery of slabs from the blooming mill to the strip mill without reheating. This roll train consists of four stands of 24" diameter by 38" long 2-high mills; six stands of 18" and 37" by 38" long 4-high mills; and three vertical edging mills. The first edging mill is located in front of the first 2-high mill; the second edger between the second and third 2-high mills; and the third edger in front of the first 4-high mill.

The arrangement of this mill differs from the usual in that all of the mills are closely grouped together. The 2-high mills have bronze bearings; the edging mills are roller bearing throughout; and the 4-high mills, in addition to the roller bearings on the backing up rolls, have roller bearings on the small or working rolls. Each of these mill stands is individually motor driven by variable speed, variable voltage motors which permits of maximum flexibility, and all stands are equipped with motor-operated screwdowns.

The speeds of this mill vary from 14 and 150 feet per minute for stand No. 1 to 725 and 1450 feet per minute for stand No. 10. It will be noted that there is a wide range of speeds available, thus permitting the selection of the speed best suited for the particular product being rolled.

The connected motor power for the main drives of this mill totals 20,550 HP, distributed as follows:

Edger No. 1	250 HP
Edgers No. 2 and No. 3	150 HP each
2-High Mill No. 1	1200 HP
2-High Mill No. 2	1600 HP
2-High Mill No. 3	2200 HP
2-High Mill No. 4	3000 HP
6 Stands of 4-High Mills	2000 HP each

This picture shows a general view of the No. 2 merchant mill.

The slabs fed to this mill vary from 2½ inches to three inches in thickness and in widths suitable for the width of product rolled. These heavy slabs can be rolled to sheet gauges continuously at high speeds, and as they are delivered from the last stand, can be cut into sheet lengths by either one of the two rotary flying shears located close to the last stand. The strip steel sheared into sheet lengths is delivered to a piler located about 375 feet from the last roll stand. The material is conveyed to either the coilers or sheet piler by an individual motor roller table.

The building housing these mills is a heavy steel frame structure covered with corrugated sheets. Particular attention was given in its design to the lighting and ventilation. The building is served by two cranes of 20 ton and 50 ton capacities.

Along the north side of the mill building is the motor room and substation in which are located all of the main motors for the three mills; the gear drives for the bar and billet mill; three 600 gal. per minute, 1000 lbs. pressure, hydraulic spray pumps, each driven by a 600 HP, 3600 RPM motor; four 30,000,000 gal. per day service water pumps, three of which are driven by 800 HP motors and the fourth of which is driven by an 800 HP steam turbine.

Also located in this building are two 2000 KW, 250 volt, D.C., M-G Sets for auxiliary power; one 7000 HP, 700 volt, D.C. flywheel set for the blooming mill motor; three 5000 KW, 600 volt, D.C., M-G Sets for the No. 1 hot strip mill; and the necessary switchboard equipment, air washers, ventilating and cooling fans.

This building is a steel frame and brick structure with an insulated roof. The cellar, some 16 feet deep and extending the entire 750 ft. length of the building, contains a maze of electric bus bars and conduits. From the cellar a good idea of the massive and well-proportioned foundations is obtained. This building is served by a 50 ton crane.

Parallel with this mill building is the coil storage and finishing building to which the coils are conveyed by means of a chain conveyor through an underground tunnel; the sheared strip is conveyed to this building by means of a 50 ton transfer car. The finishing building houses the pickling unit, the normalizing furnace, and the usual run of roller levellers, shears, oiling machines, etc.

This building serves also as a shipping building and, in addition to the finishing equipment, has the necessary scales and tracks for shipping. The building is a steel frame structure covered with corrugated sheeting and is 104 feet wide by 900 feet long served by three 15 ton cranes.

On the north side of the strip mill building is the bar and billet storage yard, which receives all of the product from the bar mill previously described. In this building are housed the sheet bar piler, billet cooling beds, and the cold bar shearing equipment, as well as the slab and billet storage racks for the merchant mill raw product. The arrangement of the building, which is served by two 15 ton cranes, is such that the piled sheet bar, slabs, or billets can be shipped direct. When billets or slabs are required for the merchant mills, they are carried from the cooling bed direct to the storage racks in the rear of the merchant mill furnace skid beds.

R. M. HUGHES
Assistant Chief Engineer

S. C. COZAD
Field Engineer

D. E. McGUIRE
Chief Draftsman

L. R. MILBURN
Electrical Engineer

Merchant Mills

There is another route of material travel to the merchant mills leading through the billet cleaning department. This department is housed in a building between the mold yard and the billet storage forming a continuation of No. 1 merchant mill building. The crane runway of this building extends over the merchant mill furnace skid bed, permitting billets to be charged directly from the cleaned billet storage racks. The billet cleaning equipment consists of a skid bed, skid bed table, approach table, cleaning cabinet with steel

grit storage and feeding mechanism, dust collector and separating equipment, delivery table, turnover, kickoff table and cradles.

No. 1 (14″) merchant mill consists of sixteen 2-high roll stands and two vertical edging mills. The mill was designed to roll steel products in sizes from ⅝″ up to 4½″ rounds, flats from 1½″ wide by No. 7 gauge to 16″ wide by No. 13 gauge and heavier, also corresponding sections including rim stock of ⅛″ minimum thickness.

The product of this mill is rolled from 6″ by 7″ billets 15 feet long and from 2½″, 3″, and 4″ square billets and 2″ thick slabs 6″ to 16″ wide 30 feet long. This raw material, as previously noted, is rolled on the bar mill and stored in racks back of the furnace skid bed.

In operation the billets or slabs, by means of magnets on an overhead electric crane, are placed on the skid bed and transferred to a roller table, which conveys them into the heating furnace. The furnace is 33 feet wide inside, with a hearth 48 feet long, and has a capacity for heating 50 gross tons of steel an hour. It is oil fired with its own oil conditioning equipment. In heating, the slabs are slowly pushed through the furnace and discharged through a side door by means of an electric ejector. Adjacent to the furnace discharge door is a hot billet shear for cutting the material into any desired length before rolling. Roller tables then convey the material to the mill where it is rapidly reduced to the desired section.

The first eight stands of this mill form a continuous roll train, each stand being individually motor driven. The first four mills of this train have rolls 21″ diameter by 39″ long and the next four mills have rolls 18″ diameter by 36″ long. Stands Nos. 9 and 10, with 18″ diameter by 30″ long rolls, are located about 135 feet from the eighth stand with stand No. 9 on the same centerline as the first eight stands. These two stands are parallel with each other and driven by a common motor. Stands Nos. 11, 12, 13, and 14 form a Belgium roll train a short distance from stand No. 8 and are driven by a common motor. These mills have 18″ and 14″ rolls. Stands Nos. 15 and 16, having 10″ rolls, are a continuation of this Belgium train and are driven by a common motor. The arrangement of the stands is such that three outlets are provided for the rolled product. Small rounds and other sections subject to looping are finished on No. 16 mill. Rounds up to 2½″, flats up to 6″ wide, and corresponding sections including angles up to 3″ x 3″ are finished on No. 14 mill. These two finishing mills have a common outlet. Larger rounds from 2½″ up to 4½″, flats up to 8″ wide and corresponding sections are finished on No. 12 mill. Flats from 6″ to 16″ are finished on No. 9 stand, which is in line with the roughing train and provides for the shearing and piling of the flats.

Conveying the material from mill to mill is a complete system of roller tables and transfers, all electrically operated and automatically controlled.

The smaller sections finished on Stands Nos. 14 and 16 are delivered to a specially designed cooling bed, 18 feet wide by 250 feet long, by means of a motor roller table, the bars in transit being stopped in the proper position with respect to the cooling bed by means of lifting apron plates, and a kickoff mechanism sweeps the bar from the runout table in such a manner that a bar can be kicked off without interference with the delivery of the succeeding bar from the mill. As the bar leaves the roller table, it is dropped into stationary grooves for the purpose of straightening. This cooling bed is designed for continuous pack annealing of spring flats, in addition to cooling squares and other sections which are fed across the bed singly or in pack formation by the carryover bars in a step by step motion to the shuffle bars which deliver the material to a motor roller runout table. The runout tables deliver the material to either of two shears where the bar is cut into the proper length for shipment.

When larger sections are required and finished on stand No. 12, the material is conveyed by a motor roller table to either a hot saw for cutting the rounds into short lengths for tube stock or to a cooling bed,

J. E. FINK
istant General Superintendent

J. A. ROCK
Superintendent of Rolling Mills

ROBERT BLACK
Superintendent of Open Hearth Dept.

WM. MORRIS
Superintendent of Bloom, Bar, and No. 1 Strip Mill

40 feet wide by 120 feet long. This bed is similar in operation to the one previously described and it also delivers the cooled material to the same runout roller tables which serve the first cooling bed.

The speed with which the material passes through the different roll stands varies from about 67 feet per minute for stand No. 1 to about 1300 feet per minute for stand No. 16.

The connected motor power for the main drives of this mill totals 7350 HP, distributed as follows:

Edger No. 1	100 HP
Edger No. 2	50 HP
Stand No. 1	300 HP
Stands Nos. 2 and 3	400 HP each
Stand No. 4	500 HP
Stands Nos. 5 and 6	600 HP each
Stands Nos. 7 and 8	700 HP each
Stands Nos. 9 and 10	1000 HP
Stands Nos. 11, 12, 13 and 14	1500 HP
Stands Nos. 15 and 16	500 HP

The building housing this mill is a well lighted and ventilated steel frame structure covered with corrugated sheets. It is 114 feet wide by 1100 feet long, served by 10 and 15 ton cranes.

The motor room is a steel frame and brick structure about 18 feet wide by 330 feet long and is parallel with the roughing train. This building has a steel plate roof with removable hatchways so that the overhead electric crane in the mill building can reach the various motors housed therein. Motor generators, switchboard equipment, air washers, ventilating and cooling fans, as well as a spray pump, are also housed in this building. Its general arrangement and construction are very similar, but on a much smaller scale, to the main motor room and substation previously described.

North of the mill building is a 100 ft. wide by 450 ft. long warehouse for finishing, bundling, and shipping of the finished merchant mill product. This building is similar in design to the mill building and in it are installed the shears and straightening machinery. The rolled product is delivered into this building by a 60 ft. long, 100 ton capacity, electric transfer car, which travels across the west end of the merchant mill building.

No. 2 (10″) merchant mill is south of and parallel with No. 1 merchant mill. It is housed in a 109 ft. wide by 1100 ft. long steel building of similar design and construction as No. 1 merchant mill building and served by 10 ton cranes.

This mill is designed to roll high-grade merchant products in sizes from $\frac{3}{8}$″ up to $1\frac{7}{16}$″ rounds, squares, hexagons, etc.; flats from 1″ to 4″ wide and from No. 12 gauge to $\frac{1}{2}$″ in thickness; concave spring steel from $1\frac{1}{2}$″ to $2\frac{1}{2}$″ wide and from No. 0 gauge to No. 6 gauge in thickness; and angles from 1″ by 1″ by $\frac{1}{8}$″ to 2″ by 2″ by $\frac{7}{16}$″; also special shapes, such as automobile side rings and clamp sections, window sash sections, bumper sections, etc. The product of this mill is rolled from 2″, $2\frac{1}{2}$″, and 4″ square billets 30 feet long. These billets are rolled in the bar mill, previously described, and stored in racks back of the furnace skid bed.

This mill is very similar in its design and arrangement to No. 1 merchant mill.

The roll train consists of 14 roll stands, the first eight forming a continuous roughing train with intermediate and finishing stands arranged very similar to those of No. 1 merchant mill. The first two stands have rolls 16″ diameter by 32″ long, the next six stands have rolls 14″ diameter by 32″ long, and the remaining six stands have rolls 10″ diameter by 16″ long.

One outlet is provided for the material rolled which is delivered to a 16 ft. wide by 255 ft. long pack annealing cooling bed of the same general design as the cooling bed for No. 1 merchant mill, the runout tables and shear arrangement also being similar.

On account of their size, these mills are plain bearing, but the pinion stands, gear drives, and roller tables are all equipped with roller or ball bearings. The speed with which the material passes through the different

L. HARTZ
Superintendent of No. 2 Strip Mill

J. P. GATHERUM
Personnel Director

WM. HILDITCH
General Master Mechanic

G. A. LEAVITT
Superintendent of Stores

W. C.
intenden
Shippir

roll stands varies from 81 feet per minute for stand No. 1 to about 1360 feet per minute for stand No. 14. Each stand of the roughing roll train is individually motor driven; intermediate stands Nos. 9 and 10 have a common motor, as have stands Nos. 11 and 12 also; and finishing stands Nos. 13 and 14 are also driven by a common motor.

The connected motor power for the main drives of this mill totals 6250 HP, distributed as follows:

Stands Nos. 1 and 2	300 HP each
Stands Nos. 3, 4, and 5	400 HP each
Stands Nos. 6, 7, and 8	550 HP each
Stands Nos. 9 and 10	900 HP
Stands Nos. 11 and 12	900 HP
Stands Nos. 13 and 14	1000 HP

The motor room is a steel frame and brick structure 36 feet wide by 179 feet long and is parallel with the roughing train. This building is similar in design and arrangement to the motor room for No. 1 merchant mill, with the exception that, in addition to housing the main mill motors, there is also located in this motor room one 5000 KW, 600 volt, M-G set, which can be paralleled with the M-G sets in motor room No. 1, and one 2000 KW, 250 volt, M-G set for auxiliary power, which can be paralleled with the M-G sets in motor rooms Nos. 1 and 5.

South of this No. 2 merchant mill and adjacent to it there is a 74 ft. wide by 1075 ft. long warehouse building of steel frame construction, covered with corrugated sheets, this building being of the same general design as the rest of the buildings. In it are located the finishing equipment, consisting of roller levellers, cold saw, straightening machines, shears, scales, etc.

RECENT INSTALLATIONS

The location and arrangement of the 96″ hot and cold strip mills is south of and parallel with No. 1 hot strip mill coil storage building.

This wide strip mill unit contains all of the latest and most modern equipment for the efficient production of high quality hot and cold strip steel in either sheet or coiled form.

Space has been provided between the end of the 96″ hot strip mill building and the soaking pit furnace building for the installation at some future date of a slabbing mill. This future slabbing mill will be in line with the 96″ hot strip mill so that, when desired, slabs can be delivered directly to the strip mill without reheating.

Seven buildings, closely grouped, having an area of more than eight hundred thousand square feet of floor space, house the equipment and provide room for finishing and shipping the products of these hot and cold strip mills. Tracks and roadways have been provided so that shipment can easily be made by rail or motor truck.

For the present the slabs required by the new hot strip mill are rolled on the existing blooming mill which it parallels and are transferred from the blooming mill slab yard by means of an electric locomotive and cars to the slab yard of the new unit where they are stored.

This mill is designed to roll strip and light plate to a width of 90 inches and has a capacity of about 60,000 tons a month.

The slab yard is a steel frame corrugated sheet covered building, 100 feet wide, 34 feet from base of column to crane rail, and 735 feet long. A 25 ton crane is used to stock the slabs and to deliver them to the magazine pusher located at one end of a roller table extending across the rear end of the slab heating furnaces. This magazine pusher is arranged to deliver one slab at a time to the roller table, which conveys it to the rear of the furnace into which it is to be charged. Each furnace is equipped with a double type furnace pusher for charging single or double rows of slabs into the furnace.

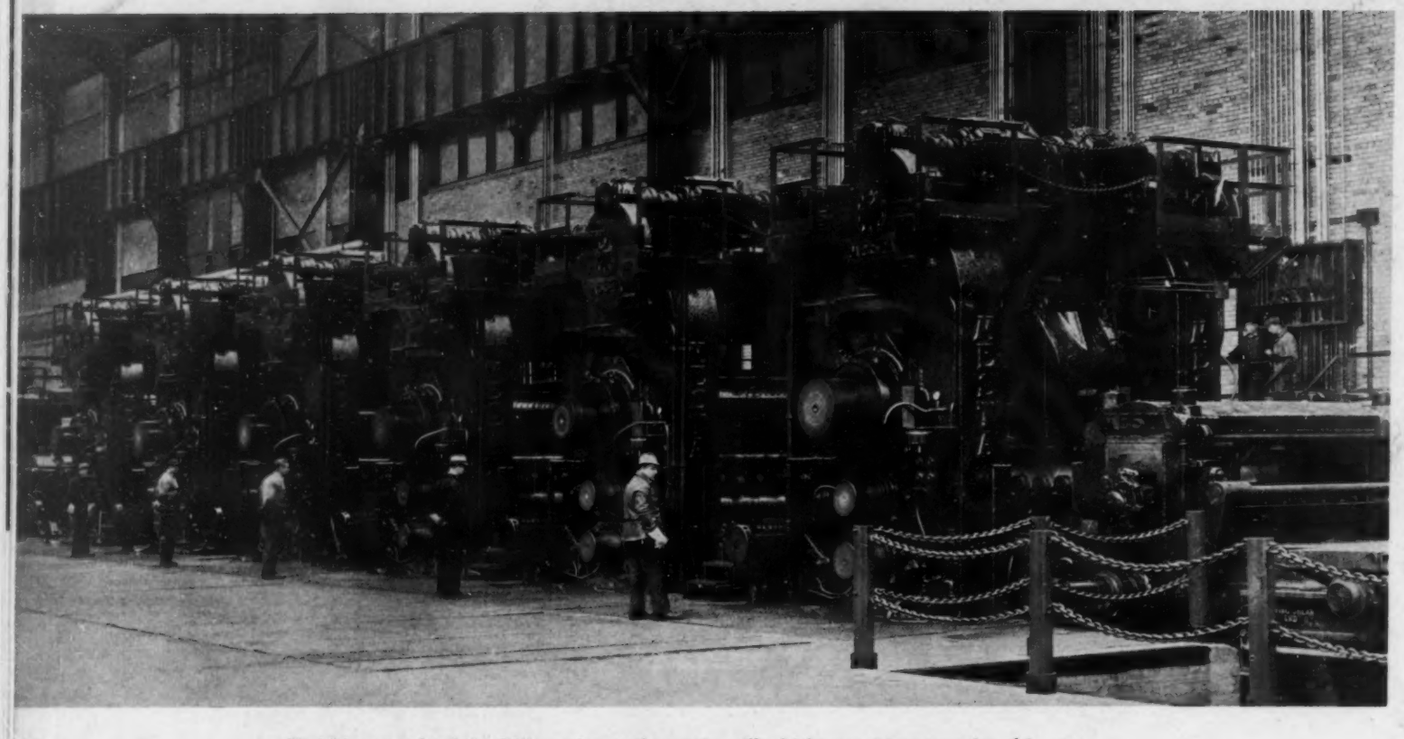
There are three slab heating furnaces, 18′ 0″ wide by 82′ 4″ long. They are of the gravity discharge type, triple oil fired. The heated slabs are discharged from the furnace onto a heavy roller table extending across

W. C. MacRITCHIE
intendent of Strip Finishing and Shipping Departments

HENRY KRAUSE
Superintendent of Merchant Mills

GEO. V. MILLER
Chief Inspector

W. H. OWEN
Yardmaster



Finishing stands of the 96" continuous hot strip mill which went into operation this year.

the front of the furnaces. This roller table conveys the slab to Scale Breaker No. 1, which is driven by a 1000 HP motor. A light reduction is made by this mill for the purpose of breaking up the furnace scale, which is cleaned off of the slab by hydraulic sprays of 1000 lbs. pressure.

When wide material is being rolled, the slabs are turned ninety degrees and then delivered to the four-high spreading stand, which is driven by a 3000 HP motor.

After passing through the spreading stand, the slabs are again turned ninety degrees and delivered to a slab squeezer, which is hydraulically operated and squeezes the slab to the desired width before entering the first of three universal four-high roughing mills.

Each of these roughing mills is equipped with vertical rolls on the entering side to maintain the proper slab width, and each mill is driven by a 3000 HP motor.

Extending between these mill stands are heavy roller tables for conveying the slab from mill to mill.

A roller table about 100 feet long conveys the slab from the last roughing mill stand to Scale Breaker No. 2, which is driven by a 500 HP motor, where a slight reduction is taken to break up the secondary scale which is also washed off by hydraulic sprays.

After passing through the second scale breaker, the slab is delivered to the first of six 4-high finishing roll stands, which are closely grouped together.

The first five finishing stands are each driven by a 4500 HP motor and the sixth or last finishing stand is driven by a 3000 HP motor.

Between each of the finishing stands are roller tables, guides, and loopers for the proper delivery of the material from mill to mill.

At various points along the roughing and finishing mill train are located 1000 lb. pressure hydraulic sprays to keep the material being rolled free from scale.

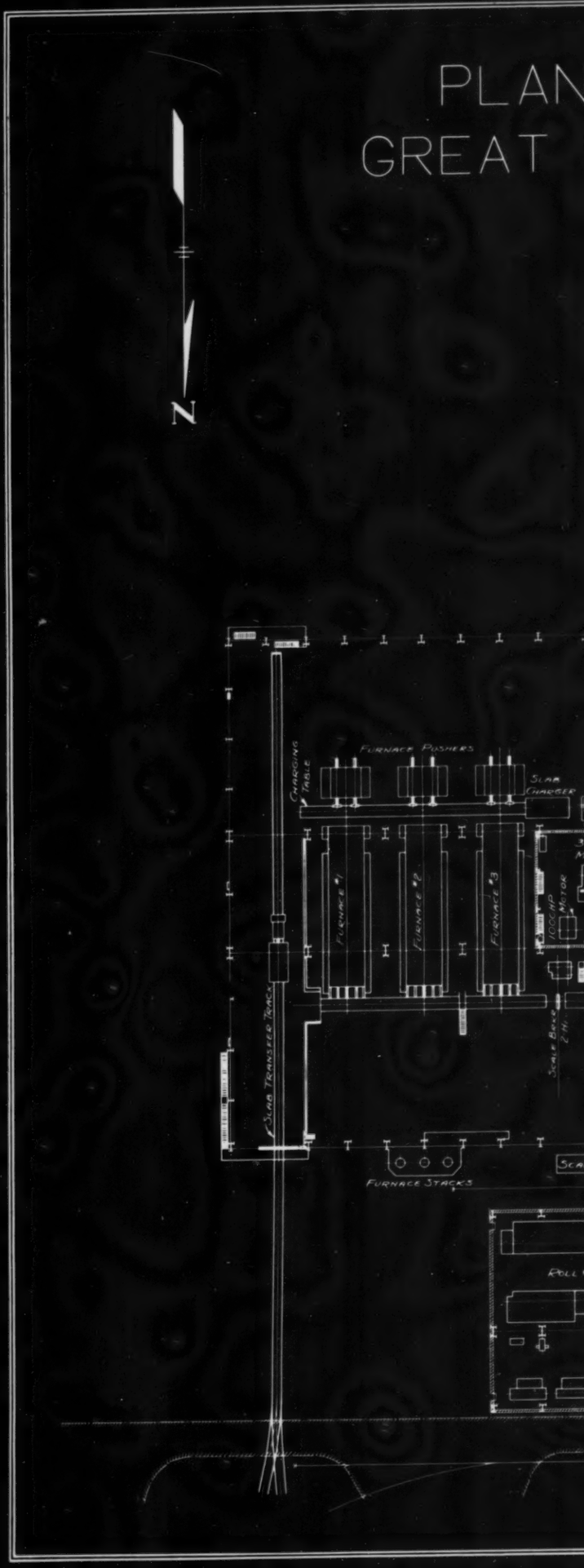
A short distance from the last finishing stand is located the rotary flying shear, which cuts the rolled material into sheet lengths. This cut-to-length material is conveyed by means of roller tables to either one of two sheet pilers. The cut-to-length piled strip sheets are removed from the piler by an overhead crane with carrying hooks and placed on skids and allowed to cool, after which they are trimmed, roller levelled, cut to exact length, normalized, pickled, or given whatever finishing treatment the particular order requires.

When coiled material is required, the strip after leaving the last finishing stand is conveyed by roller tables to either one of two hot strip coilers located about 385 feet from the last finishing stand. Here the long hot strip is converted into a coil having a 24 inch inside diameter and a 44 inch outside diameter. From these coilers the coiled material is discharged onto an underground conveyor which carries the coils to the coil storage building where it is stored and allowed to cool.

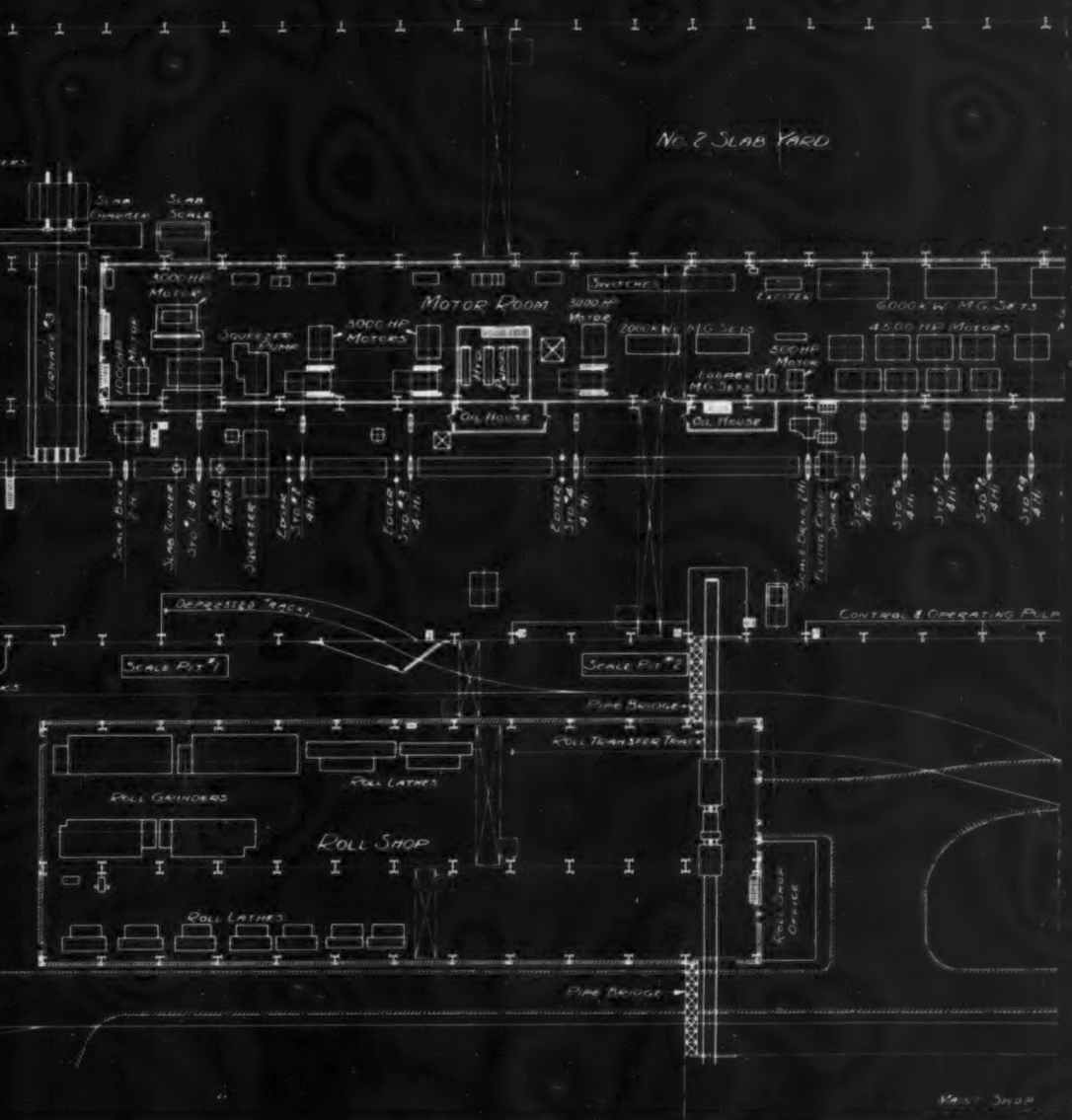
The building housing the hot strip mill is 100 feet wide, 42 feet from base of column to crane rail, and 1910 feet long. Two 75 ton cranes for roll changing and two 25 ton cranes for material handling serve this building.

Space has been provided between the mill runout tables and the south building columns for a future cooling bed with plate levelling and conveying equipment.

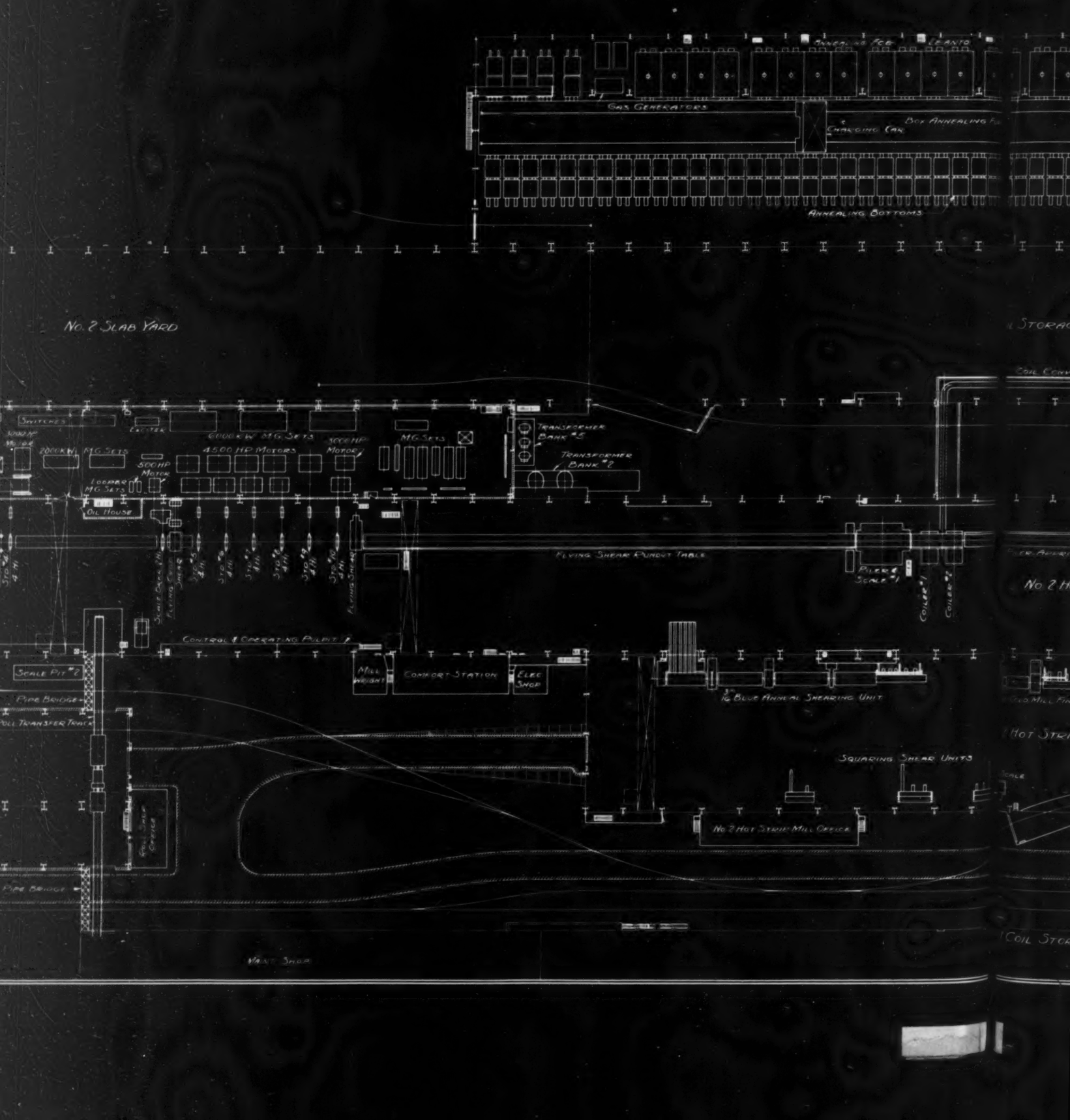
At the west end of the building are located two units for trimming, levelling, and shearing the hot strip material. A normalizing and blue annealing furnace

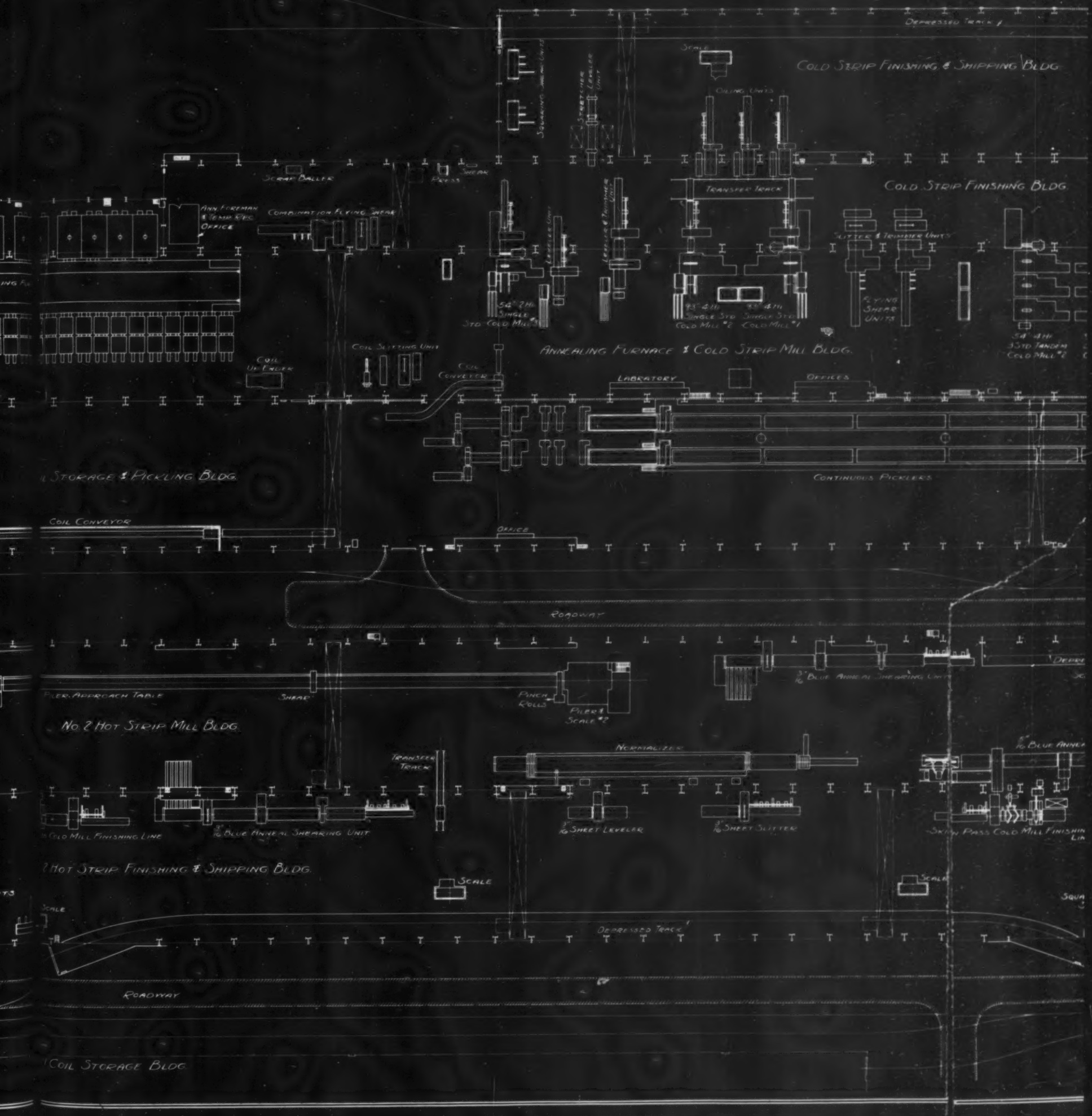

PLAN
GREAT
N
FURNACE PUSHERS
SLAB CHARGER
CHARGING TABLE
FURNACE #1
FURNACE #2
FURNACE #3
100 HP MOTOR
SLAB TRANSFER TRACK
FURNACE STACKS

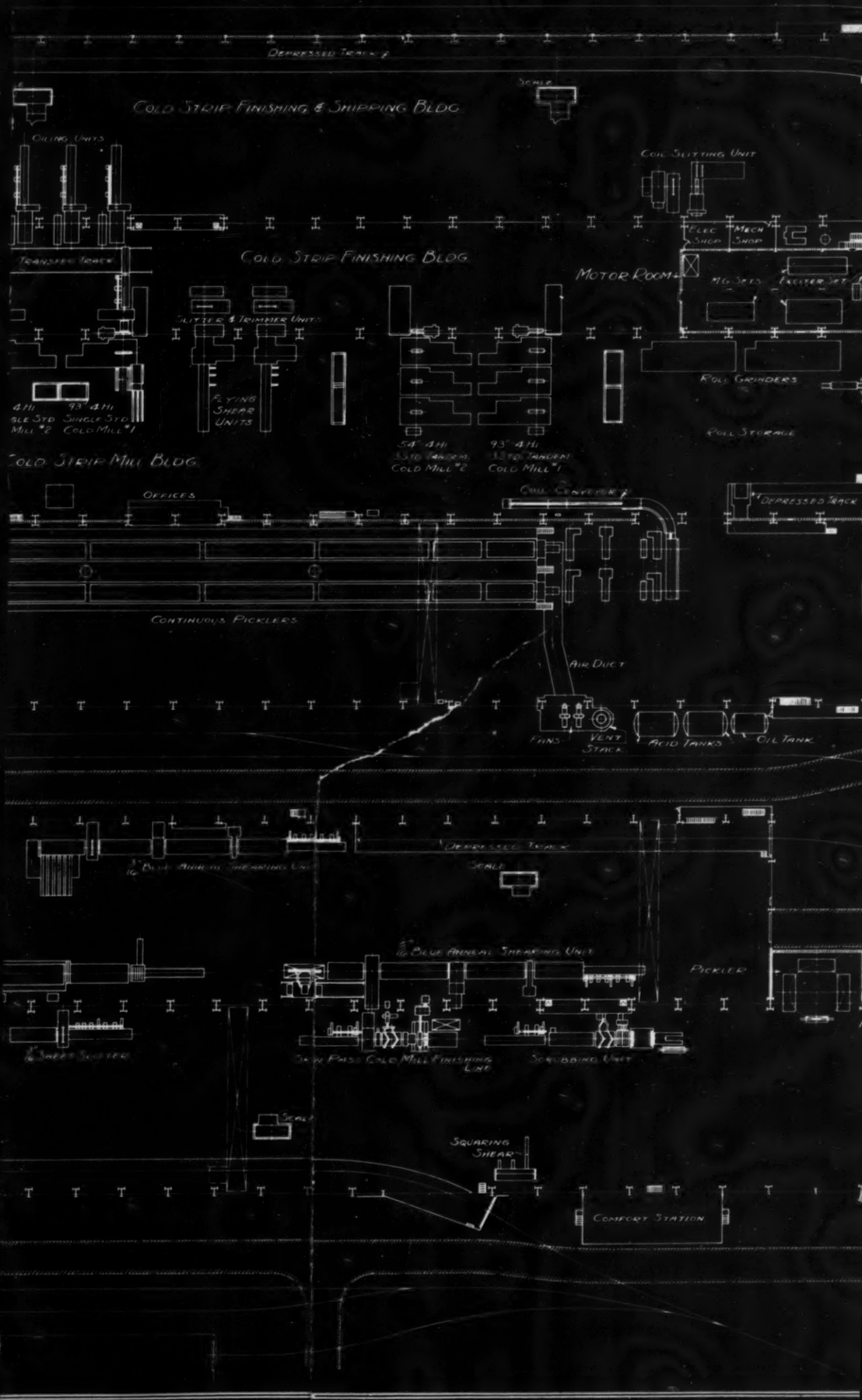
PLAN VIEW-CONTINUOUS HOT
EAT LAKES STEEL CORPORAT



TINUOUS HOT & COLD STRIP MILL
EEL CORPORATION-ECORSE, MICHIGAN




Depressed Track
Scale
Cold Strip Finishing & Shipping Bldg
Oiling Units
Squaring Shear Units
Stretcher Leveller Unit
Scrap Baller
Press
Shear
Ann Foreman & Temp Rec Office
Combination Flying Shear
Transfer Track
Cold Strip Finishing Bldg.
Leveller Unit
Leveller & Trimmer Unit
Slitter & Trimmer Units
54" 2 Hi Single Std Cold Mill #3
Flying Shear Units
54" 4 Hi Single Std Cold Mill #2
54" 4 Hi Single Std Cold Mill #1
54" 4 Hi 3 Std Tandem Cold Mill #2
Coil Slitting Unit
Coil Up Coiler
Coil Conveyor
Annealing Furnace & Cold Strip Mill Bldg.
Laboratory
Offices
Storage & Pickling Bldg.
Continuous Picklers
Coil Conveyor
Office
Roadway
Pier Approach Table
Shear
Pinch Rolls
Pier & Scale #2
3" Blue Anneal Shearing Unit
No. 2 Hot Strip Mill Bldg.
Transfer Track
Normalizer
Cold Mill Finishing Line
3" Blue Anneal Shearing Unit
2" Sheet Leveler
1" Sheet Slitter
Skin Pass Cold Mill Finishing Line
2 Hot Strip Finishing & Shipping Bldg.
Scale
Depressed Track
Roadway
Coil Storage Bldg.


Depressed Track #
Scale
Cold Strip Finishing & Shipping Bldg.
Oiling Units
Coil Slitting Unit
Elec Shop
Mech Shop
Transfer Track
Cold Strip Finishing Bldg.
Motor Room
M.G. Sets
Exciter Set
Slitter & Trimmer Units
Roll Grinders
Flying Shear Units
4 Hi Single Std Mill #2
93" 4 Hi Single Std Cold Mill #1
54" 4 Hi 3 Std Tandem Cold Mill #2
93" 4 Hi 3 Std Tandem Cold Mill #1
Roll Storage
Cold Strip Mill Bldg.
Offices
Coil Conveyor #
Depressed Track
Continuous Picklers
Air Duct
Fans
Vent Stack
Acid Tanks
Oil Tank
Depressed Track
Scale
Pickler
Sheet Slitter
Scrubbing Unit
Scale
Squaring Shear
Comfort Station

SHIPPING OFFICE
EXCITER SET
DUST COLLECTOR & FAN HOUSE
BLAST MACHINE
TRANSFORMER BANK
DEPRESSED TRACK
COMPRESSOR STATION
WATCHMAN
FOOT BRIDGE
ROADWAY
OIL TANK
ACID SUMP
ACID TANK
HOT WATER TANK

is also located in this building. This furnace is 108 inches wide by 140 feet long. It has an 80 ft. heating zone and a 60 ft. cooling zone. Both zones of the furnace are equipped with oil fired combustion ducts wherein the fuel is converted into a gaseous medium. The conveyor in the heating zone consists of alloy shafts and discs, the shafts being supported on alloy roller bearings within the furnace. In the cooling zone watercooled shafts and alloy discs are used. The furnace conveyor shafts extending through the furnace side wall are direct connected through bevel gears to a line shaft extending the entire length of the furnace. This line shaft is divided into three sections, each section being provided with its individual driving unit, which permits the material to pass through the furnace at a speed of 10½ to 42 feet per minute. The charging end of the furnace is equipped with a pinch roll and feed table, and at the discharge end is a suitable runout table, roller leveller, and piler.

Motor Room

Between the mill building and the slab yard is a 60 ft. wide by 525 ft. long motor room and substation in which are housed the gear drives and motors for the roughing and finishing mills, the motor generators, switchboard and control equipment. Also located in the motor room are three 1000 lb. pressure 1000 gal. per minute centrifugal spray pumps driven by 800 HP motors. In the basement of this motor room are located the air coolers and ventilating fans. The generating equipment consists of:

2—2000 KW, 250 volt, D.C., Auxiliary Power Generator Sets
3—6000 KW., 600 volt, D.C., Main Drive Generator Sets
1— 700 KW, 600 volt, D.C., Flying Shear Generator Set
2— 25 KW, 40 volt, D. C. Looper Generators
1— 500 KW, 250 volt, D.C. Exciter Set
4— 800 KW, 680 volt, A.C., Variable Frequency Generator Sets
1—150 KW, 680 volt, A.C., Variable Frequency Generator Set
2—288 KW, 680 volt, A.C., Variable Frequency Generator Sets
1—300 KW, 50 volt, D.C., Dynamic Braking Generator Set

The motor room is ventilated and cooled by the recirculation of 410,000 cubic feet per minute of air passing over 70,650 square feet of coolers requiring 2,350 gallons of water per minute. 25,000 cubic feet of makeup air is required which passes through air filters located at the west end of the motor room. 398 motor horsepower is required for driving the ventilating fans.

The motor room is a steel frame building with brick walls and an insulated steel roof. A 50 ton crane serves this building.

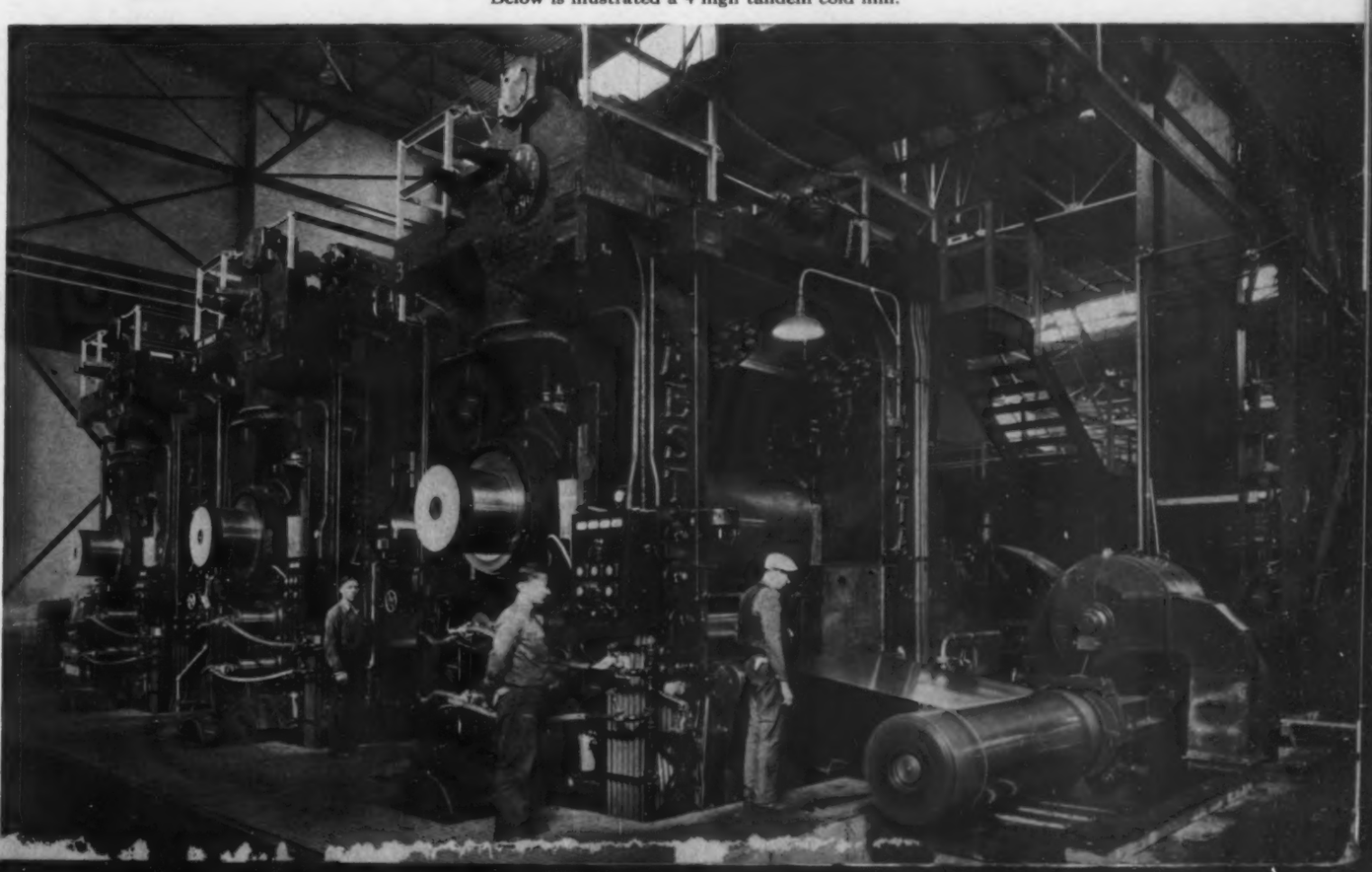
Finishing Department

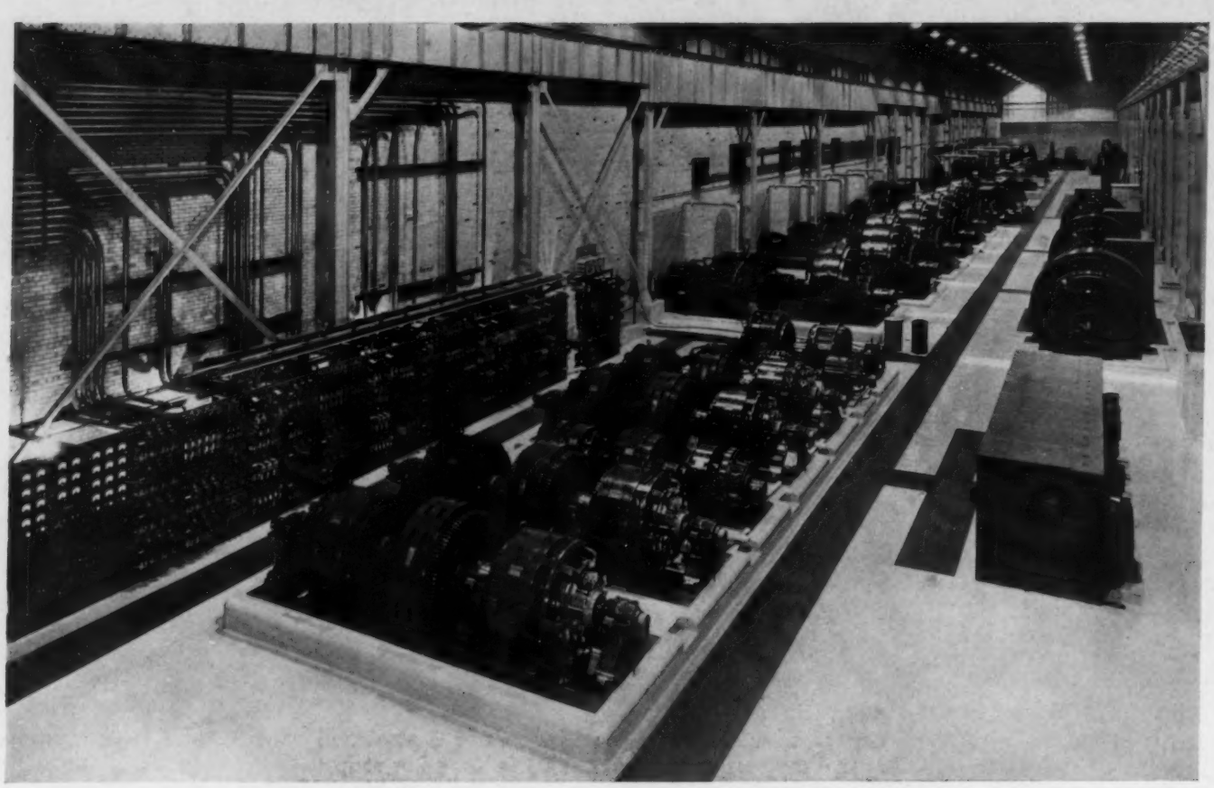
North of the hot mill building is a 100 ft. wide by 1275 ft. long hot strip finishing building in which are located the trimming, levelling, and shearing units, skin pass cold mills, squaring shears, sheet pickler, etc. This building also serves as a shipping department and has a depressed track for car shipments located at one side of the building.

The coil storage and continuous pickling building is located 60 feet south of the hot strip mill building and is a continuation of the slab yard. It is 100 feet wide by 1225 feet long.

Two continuous pickling lines are located in this building. Provision has been made for the installation at some future time for a third continuous pickler. Each pickling line consists of a loading conveyor, coil

Below is illustrated a 4 high tandem cold mill.





General view of the motor room for the 96″ hot strip mill.

This picture shows a general view of the motor room basement in the 96″ hot strip mill.

R. H. REAZOR
perintendent of Masonry

L. SELMI
Chief Metallurgist

THOS. SMITH
Roll Designer

J. M. TINSLEY
Superintendent of Labor Dept.

upender, feed reel, combination processor and straightener, upcut shear, stitcher, and pinch rolls at the charging end followed by four 96 inch wide by 60 ft. long acid tanks and two 96 inch by 26 ft. long cold and hot water tanks. At the delivery end of the continuous picklers are located a hot air dryer, pinch rolls, upcut shear, oiling rolls, and coiler.

The coils are delivered from the coil storage by means of an overhead crane and magnet and placed on the loading conveyor, which delivers them to the upender, which in turn turns the coils on their side and discharges them onto a short conveyor having a tilting section for discharging the coils onto a runway to the feed reel.

The strip is run through the continuous pickler at a speed of 55 to 165 feet per minute and, after being coiled, is discharged onto a conveyor, which delivers it to the cold mill rolling building.

The cold mill building is 100 feet wide by 1300 feet long. At the west end of this building is located the cold rolling equipment, consisting of one 54 inch and one 93 inch three-stand four-high tandem cold mills; two 93 inch four-high single-stand skin pass mills; and one 54 inch two-high single-stand skin pass mill.

Each stand of the four-high cold mills is driven by a 1200 HP motor and the 54 inch two-high cold mill is driven by a 250 HP motor. Each tandem mill is equipped with coil box and tension reel.

One 93 inch single-stand mill is equipped with a back tension feed reel and a tension reel for coiled material and also with a sheet charger, conveyor, leveller, and piler for sheets. The second 93 inch single-stand mill is equipped for skin pass rolling sheets only.

The 54 inch two-high cold mill is equipped for skin pass rolling of both sheets and coiled material.

Three automatic shearing and trimming units cut the cold rolled material to sheet lengths.

Two roll grinders and space for roll storage are located between the west end of the building and the tandem mills.

Adjacent to the cold mill building is a 60 ft. wide by 825 ft. long building and adjacent to this building is a 100 ft. wide by 600 ft. long building in which are located the finishing equipment, such as levellers, slitters, oiling machines, squaring shears, etc. This last building is also used as the shipping building and has a depressed track for car shipments along the south side of the building.

At the east end of the cold mill building are the cooling beds for the box annealing furnaces. These furnaces are housed in a 25 ft. wide by 475 ft. long

T. C. MAYBERRY
erintendent of Cold Mills

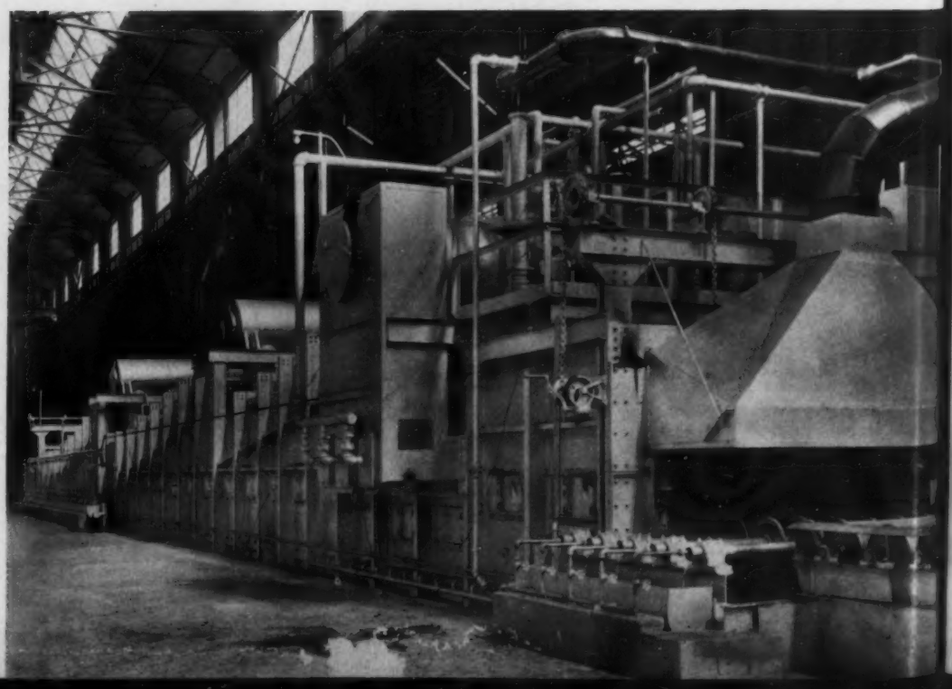
E. J. McCLEARY
Manager, Hanna Furnace Division

HOMER STEELE
Superintendent, Michigan Steel Div.

L. M. RIPPLE
Superintendent of Electrical Dept.

General view of the continuous picklers in the new cold mill.

Conveyor and up-ender at the end of the continuous picklers.



View of normalizing furnace which is 140 feet long and 108.inches wide.

leanto on the south side of this building. There are five batteries of four double box length annealing furnaces and these furnaces are of the in-and-out type, oil fired. They are well constructed, fully insulated, and equipped with temperature recording instruments. A specially designed charging machine, operating on a track extending along the front of the battery of furnaces, is used for charging the annealing boxes into the furnaces and placing the annealed material on the cooling beds.

At the east end of the annealing furnaces are three 15,000 cubic feet per hour reformed gas machines for supplying the necessary dioxidized gas which is made from 530 btu. city gas.

Underneath and back of the annealing furnaces a cellar extends the entire length of the battery of furnaces. In this cellar are located the oil conditioning equipment; the furnace blowers; and the oil, steam, and air piping.

The cold mill buildings are of the high and low bay type, with brick side and end walls, and have steel insulated roofs.

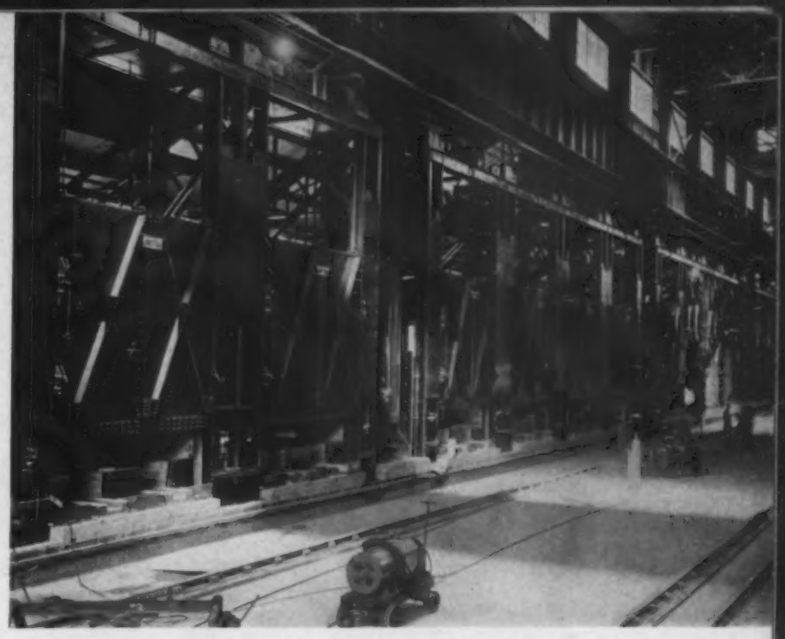
At the west end of the cold mill finishing building is located a 45 ft. wide by 100 ft. long substation, which houses one 6000 KW; one 2800 KW four unit 600 volt; and one 2000 KW, 250 volt M G sets for furnishing the D.C. power for the cold mills and auxiliary equipment. Extending from the basement of this Substation is a system of tunnels to the various main motors of the cold mills. In these tunnels are run the main bus for carrying the power to the cold mill motors. The auxiliary controls and switchboards are located in these tunnels, through which is also delivered the necessary makeup air for cooling the mill drive motors.

205,200 cubic feet per minute of air is recirculated for cooling the M-G sets and motors of the cold mills which passes through coolers having an area of 17,365 square feet. These coolers require 1100 gallons of water per minute. Air filters located in the west end of the motor room basement deliver 25,000 cubic feet per minute of makeup air. The ventilating fans for this system require 215 motor horsepower.

Auxiliary Equipment

The backing up roll bearings, pinions, and gear drives for the hot and cold strip mills are lubricated by five centralized automatic oil systems located in the cellars underneath and adjacent to the mill foundations. The hot mill has three systems and the cold mills two systems. The return storage tanks vary in size from 6,000 to 11,900 gallons. Each system is complete with the necessary pumps, filters, centrifuges, heaters and coolers, and indicating and recording instruments.

The roller bearings of the various roller tables and auxiliary equipment are lubricated by centralized greasing systems, of which there are seven installed. A number of these are fully automatic and others are connected to a pipe header extending along the mill tables or carried under the crane girders to a number of individual machines. This grease pipe header is under pressure and permits the lubrication of the individual machines by means of a hose and special grease gun without the necessity of hand pumping.



View of the box annealing furnaces in the new cold mill.

To summarize, the foundations for the buildings and equipment of this plant required 270,000 cubic yards of concrete.

The buildings cover an area of 2,325,000 square feet, or about 53 acres. These buildings required 58,000 tons of structural steel. Three and one-half million square feet of corrugated steel sheeting were required for the sides and roofs of these buildings. Four hundred and ninety thousand square feet of builtup roofs, consisting of steel deck, insulation, and waterproofing, were also required. The steel side wall and monitor sash equaled 495,000 square feet.

The connected motor horsepower for the main and auxiliary drives for the various units of this plant equals 280,000 HP.

Sixty-five cranes, varying in size from 5 to 250 tons, serve the various buildings.

Five Diesel oil electric and eight steam locomotives are required to handle the raw and finished material over the many miles of track within the plant.

Pig iron for the Open Hearth Furnaces is obtained from the Hanna Blast Furnaces located on Zug Island, a distance of about three and one-half miles north of the steel plant. It is transported in its molten state in 110 ton Hot Metal Mixer Type cars over the Detroit, Toledo and Ironton railway and delivered to the end of the Open Hearth building where it is transferred to 75 ton ladles for charging into the furnaces.

Sheet bars and strip breakdowns are delivered to the Michigan Sheet Mills located about one and one-half miles south of the steel plant.

These Blast Furnaces and Sheet Mills are a part of the Great Lakes Steel Corporation which is a unit of the National Steel Corporation.

The above are a few of the major items comprising this plant. Time and space do not permit the listing of the hundreds of auxiliary items of equipment installed, all of which combined make this a modern and efficient steel plant located in the greatest steel-consuming market in the country.

In the new Great Lakes Continuous Mill, 164 points of lubrication on the 2 "Mesta" Hot Strip Coilers are automatically lubricated by one Farval Motor-Driven, Centralized System of Lubrication . . . .

● With the mill in full production, a single push-button control provides complete lubrication of all bearings on either coiler or both, and none are missed.

On 10 other Hot Strip Coilers, Farval has increased production by eliminating sticking coils—provided power savings up to 25%—and has kept the bearings in perfect condition after three years of continuous service.

Even greater savings have been made on some 250 Rolling Mill Stands, and we would be glad to send a nearby Representative with full particulars. The Farval Corporation, 3278 East 80th Street, Cleveland, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Manufacturers of Automotive and Industrial Worm Gearing.

FARVAL

CENTRALIZED SYSTEM OF LUBRICATION

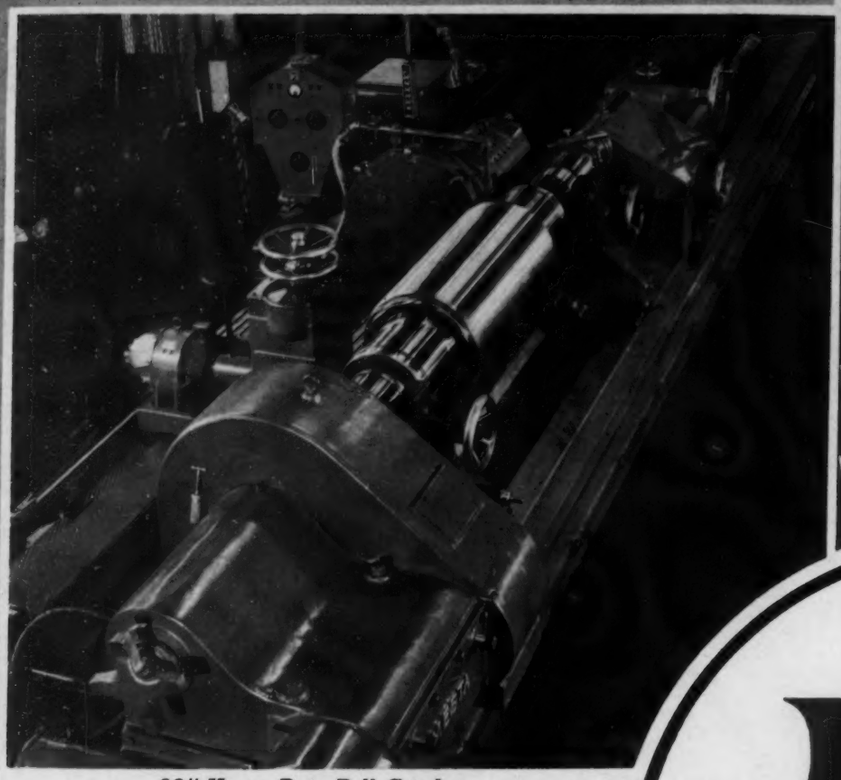
Special Delivery to Every Bearing

Mills of the Great Lakes Steel Corporation - built by

MESTA

1936.

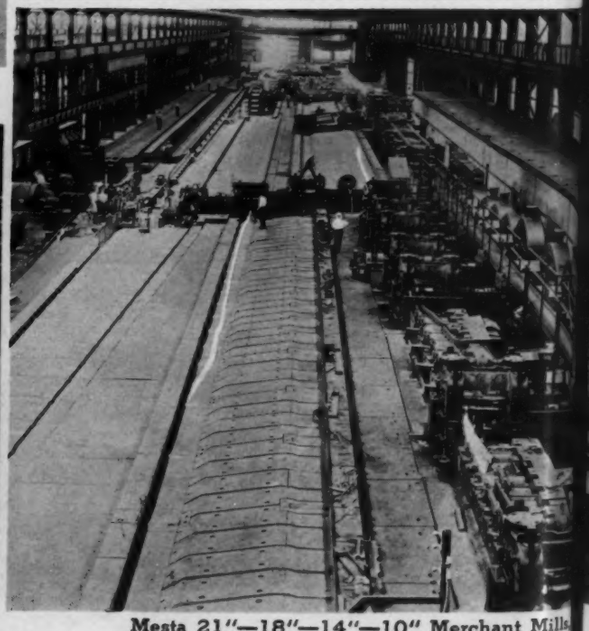
INSTALLATIONS of MESTA ROLLING MILL EQUIPMENT at GREAT LAKES STEEL CORPORATION



60" Heavy Duty Roll Grinder

Four-High Continuous Hot Strip Mill

96" Four-High Continuous Hot Strip Mill

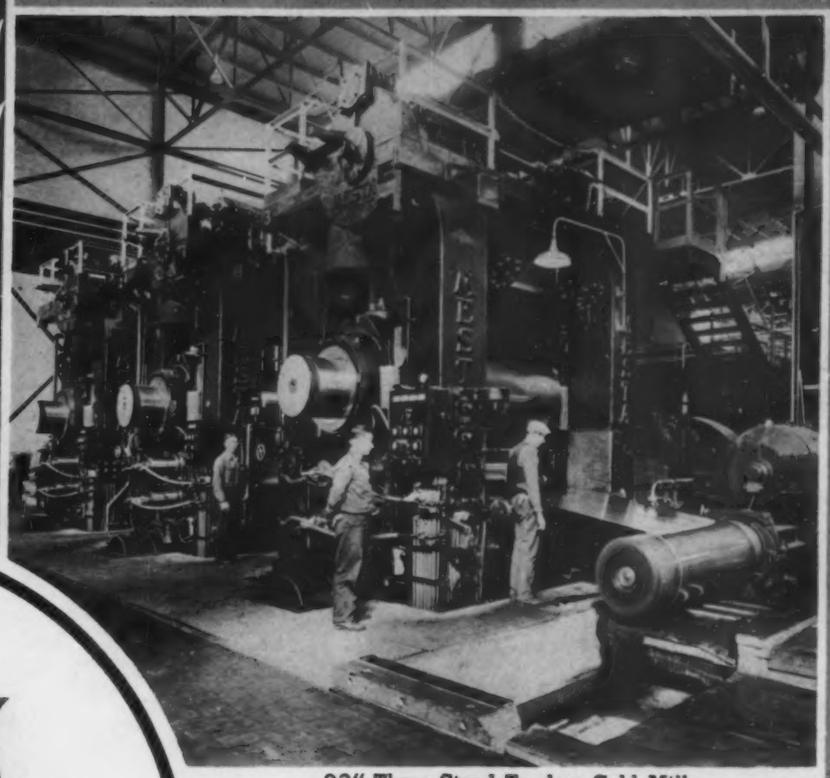


Mesta 21"—18"—14"—10" Merchant Mills
Pack Annealing Cooling Bed and Equipment

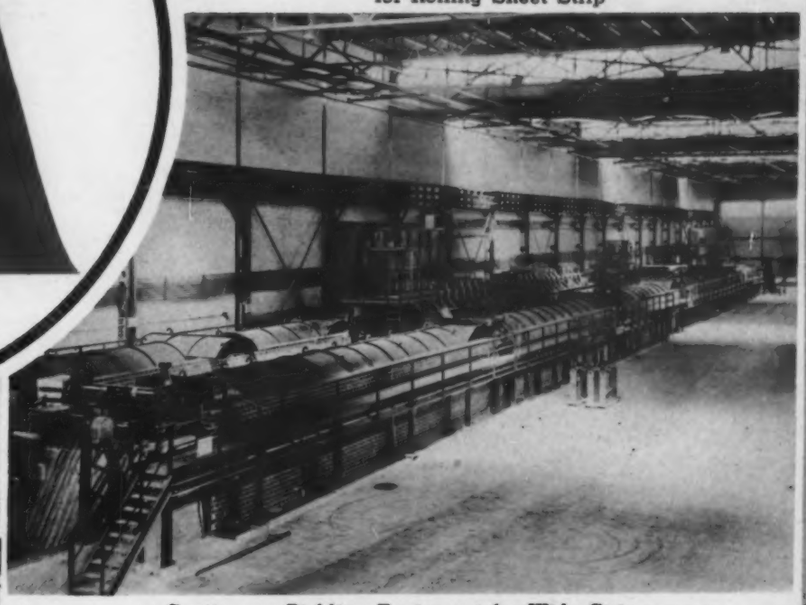
The growth of the Great Lakes Steel Corporation has been marked with unusual success and rapidity. Their modern mills—blooming mill, bar and billet mill, merchant mills, continuous hot strip mills, continuous cold strip mills, and auxiliary equipment—are Mesta built.

It is significant that Mesta has had the privilege of furnishing the many mill machinery requirements of this great concern.

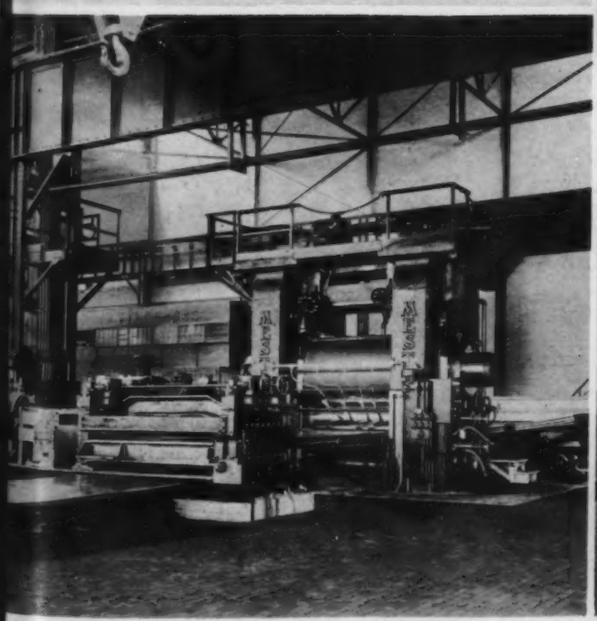
MESTA



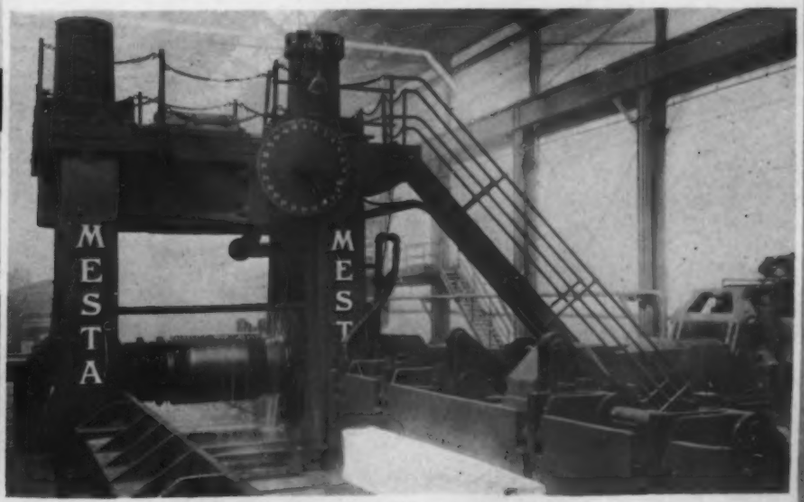
93" Three Stand Tandem Cold Mill for Rolling Sheet Strip



Continuous Pickling Equipment for Wide Strip



93" Single Stand Four-High Cold Mill for Rolling Sheets



Blooming Mill and Manipulator

•MESTA PRODUCTS

Steel Mill Equipment

Bar Mills
Billet Mills
Blooming Mills
Merchant Mills
Piercing Mills
Plate Mills
Rail Mills
Sheet Mills
Slabbing Mills
Strip Mills
Structural Mills
Tin Plate Mills
Tire Mills
Tube Mills
Universal Mills
Wheel Mills
Mill Tables
Manipulators
Bar Shears
Billet Shears
Bloom Shears
Doubling Shears
Hydraulic Shears
Lever Shears
Plate Shears
Squaring Shears
Steam-Hydraulic Shears
Hot Metal Saws
Gear Drives
Transfers
Mesta Patented Feed Reels
Tension Reels
Levellers
Cooling Beds
Pack Annealing Beds
Trimmers and Slitters
Coilers
Electric Cleaners
Continuous Picklers
Roll Grinders Roll Lathes

Continuous Mills and Mesta Patented Flying Shears

Four-high Hot Mills and Four-high Cold Mills

Miscellaneous Machinery

Cut and Machine Molded Iron and Steel Gears, Flexible Couplings, Hydraulic and Steam Hydraulic Forging, Bending and Forming Presses, Accumulators, Planers, Draw Cut Shapers, Air Compressors, Large Power Presses, Barometric Condensers, Vacuum Pumps, Annealing Boxes

Gas and Steam Engines for Blast Furnaces, Rolling Mills and Power Plants

including

Una-Flow Engines (Stumpf Patents)
Piston and Corliss Valve Engines
Reversing Engines Blowing Engines

Rolls and Mill Pinions

Steel and Alloy Steel Rolls Mesta Grain Rolls
Chilled and Sand Iron Rolls
"Mesta Special" Alloy Steel Rolls
Mesta Hardened Chill Rolls
Mesta Hardened Grain Rolls
Heat Treated Special Alloy Steel Rolls
Backing Up Rolls
Cut Tooth Mill Pinions
Machine Molded Mill Pinions

Mesta Patented Pickling Machines

Mesta Automatic Plate Valves (Iversen Patents)

Forgings

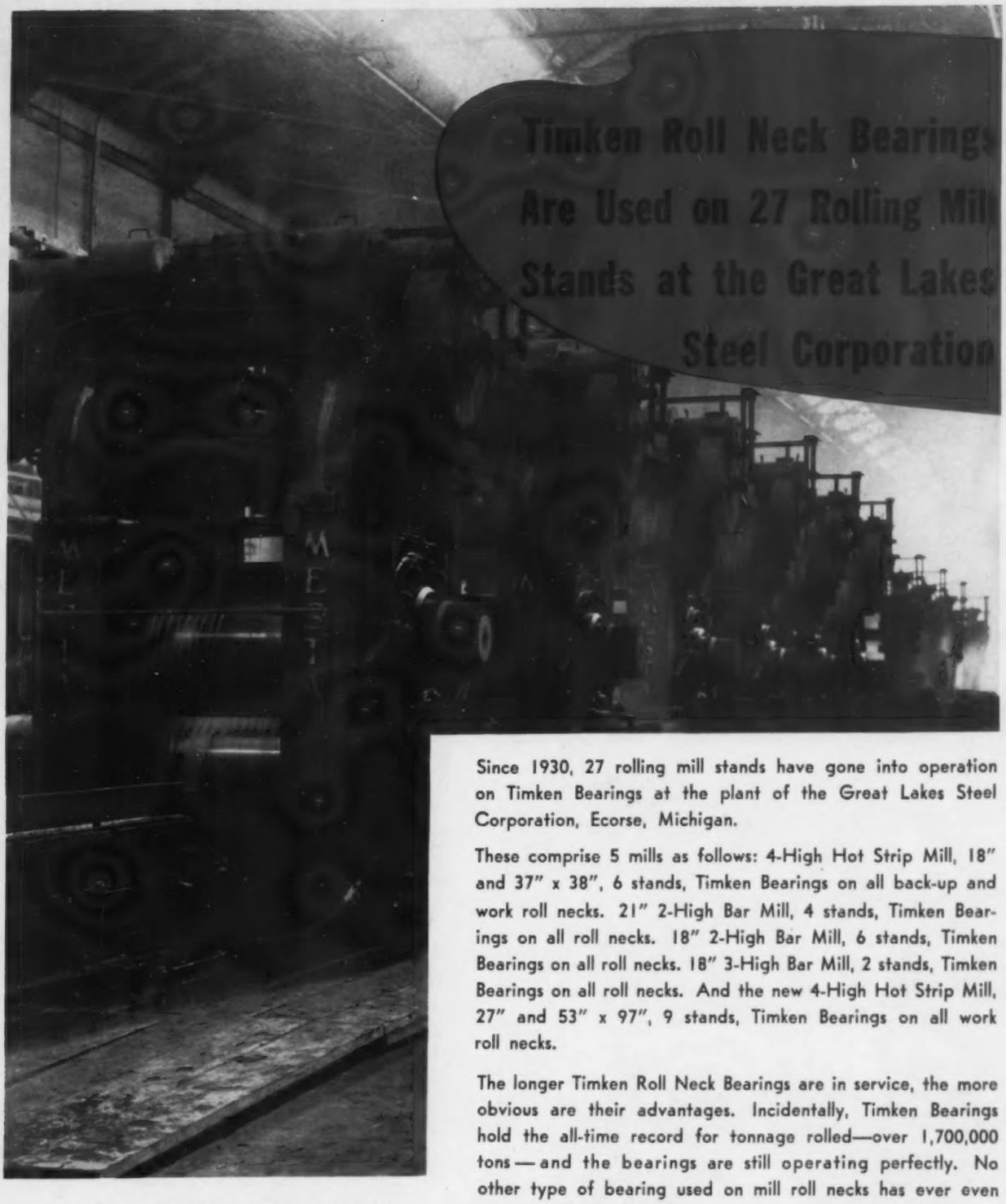
Large Shafts, Ship Shafts, Billets, Piston Rods, Connecting Rods, Locomotive Axles and General Forgings

Castings

Acid Open Hearth, Carbon and Alloy Steel Castings and Forging Ingots, Air Furnace Iron Castings, Bronze Castings

MESTA MACHINE COMPANY

PITTSBURGH, PA.



18" and 37" x 38" 4-High Hot Strip Mill placed in operation in 1931. 6 stands equipped with Timken Bearings on all back-up and work roll necks.

Since 1930, 27 rolling mill stands have gone into operation on Timken Bearings at the plant of the Great Lakes Steel Corporation, Ecorse, Michigan.

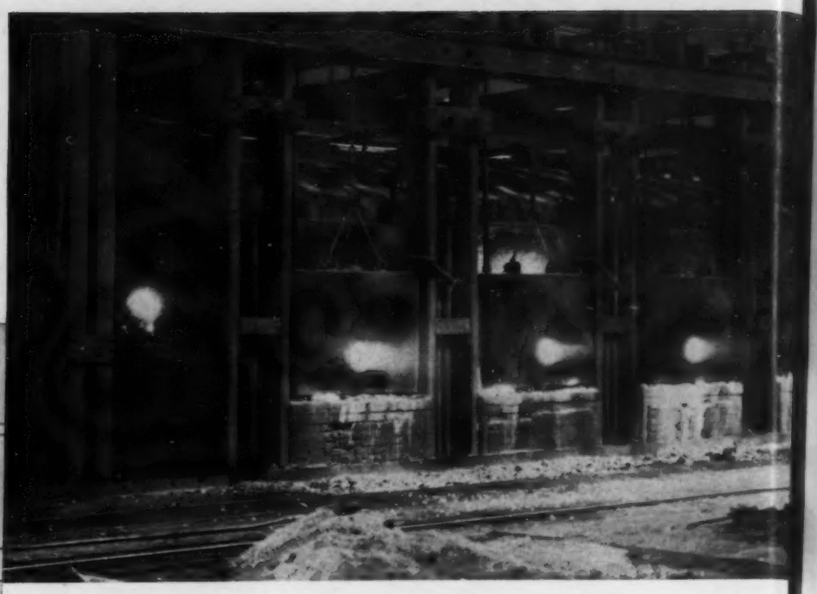
These comprise 5 mills as follows: 4-High Hot Strip Mill, 18" and 37" x 38", 6 stands, Timken Bearings on all back-up and work roll necks. 21" 2-High Bar Mill, 4 stands, Timken Bearings on all roll necks. 18" 2-High Bar Mill, 6 stands, Timken Bearings on all roll necks. 18" 3-High Bar Mill, 2 stands, Timken Bearings on all roll necks. And the new 4-High Hot Strip Mill, 27" and 53" x 97", 9 stands, Timken Bearings on all work roll necks.

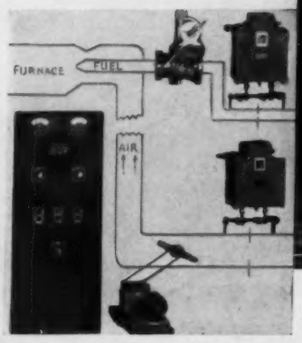
The longer Timken Roll Neck Bearings are in service, the more obvious are their advantages. Incidentally, Timken Bearings hold the all-time record for tonnage rolled—over 1,700,000 tons — and the bearings are still operating perfectly. No other type of bearing used on mill roll necks has ever even approached that record.

THE TIMKEN ROLLER BEARING CO., CANTON, OHIO

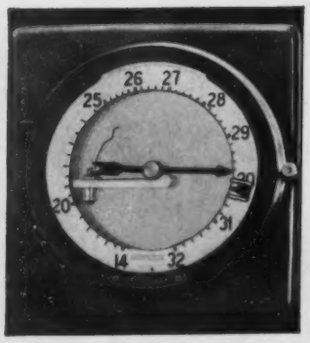
TIMKEN *TAPERED ROLLER* **BEARINGS**

Here's *Help* For The First Helper

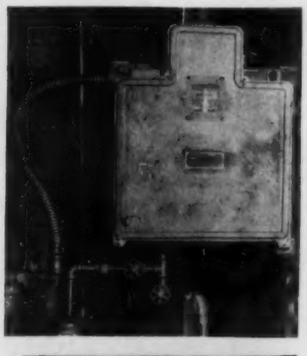




First Helper secures any desired combustion with L&N Combustion Control.



First Helper holds roof at efficient high temperature with perfect safety, when this L&N Roof Temperature Controller helps. Furnace Pressure Controller, at right, gives sting, infiltration, flame position, etc., as desired.



First Helper has furnace reversed when temperatures require, by using this L&N Reversal Controller.

First Helper has complete record of o-h temperatures with this Micromax Temperature Recorder.

RESPONSIBLE for making steel as rapidly as possible and with minimum fuel consumption, the First Helper can operate his open-hearth more uniformly, more quickly and more positively with the assistance of L&N O-H Furnace Controls.

With these controls, regulation is available for furnace pressure, fuel-air ratio, reversal, roof temperature—any one or in any combination—from full manual to full automatic. The First Helper can turn from one to the other and back again at will. He can have some controls automatic and the others manual. In a word, he can have as much help or as little as he likes, and can have it whenever he wants it. He makes steel of desired quality in a shorter time, with large saving of fuel and substantial increase in tonnage per furnace.

Most Controls have paid for themselves in a very few weeks, and their general value is shown by the many repeat orders we have received. A short experience or even a careful inspection of the Controls convinces open-hearth men of their simplicity and sturdiness, of their ability to deliver the dependable control needed for furnace operation. If your plant could profit by better open-hearth operation, let us help by making available our engineering service.

See the L&N Exhibit at the Iron and Steel Show

LEEDS & NORTHRUP COMPANY

4942 STENTON AVENUE PHILADELPHIA, PA.

LEEDS & NORTHRUP

J-643 (7)

MEASURING INSTRUMENTS • TELEMETERS • AUTOMATIC CONTROLS • HEAT-TREATING FURNACES

KANE & ROACH

METAL WORKING MACHINERY

No. 2A Combination Vertical and Horizontal Straightening Roll. 12 Vertical Rolls. 12 Horizontal Rolls.

Builders of

Straightening Rolls

Bending Rolls

Cold Roll Forming Machines

Special
Metal Working Machines

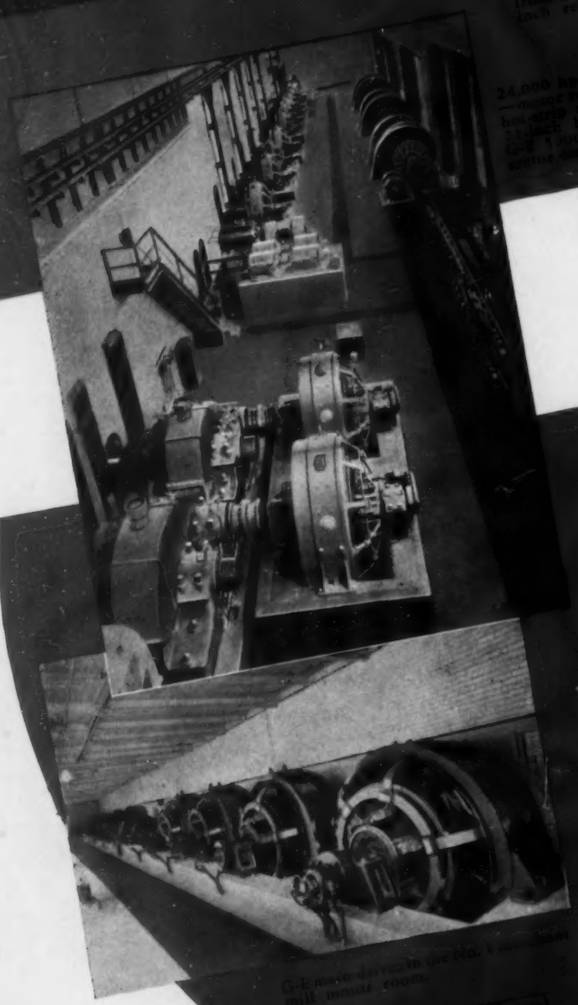
No. 23 Horizontal Angle Bending Roll

Kane & Roach Machinery
Installed at
Great Lakes Steel Corporation

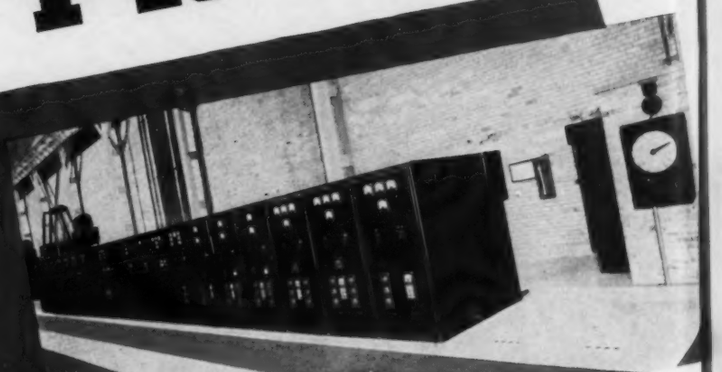
KANE & ROACH
INCORPORATED
Syracuse, New York
Established 1887

No. 4L 5-550S Cold Roll Forming Machine,
No. RB Combination Straightening Machine
and No. 3 D Flying Cutoff.

The INITIAL Installation 1930



PROVED



G-E d-c motors driving finishing stands in the new Great Lakes 96-inch hot-strip mill

The NEW Mill 1936

GENERAL

DEPENDABILITY

GREAT LAKES

again chooses

Motor room, Great Lakes 96-inch hot-strip mill No. 2, from finishing end. G-E motors, 39,000 hp strong, drive finishing stands and roughing stands

GENERAL ELECTRIC EQUIPMENT

AFTER more than five years of dependable operation of General Electric equipment, Great Lakes Steel Corporation, of Detroit, again selects G-E apparatus for its mammoth new 96-inch hot-strip mill. The experience of this progressive manufacturer with the entire line of G-E products called for a repeat order. The new mill is now installed and operating, and you who attend the annual convention of Iron and Steel Engineers in Detroit, September 22-25, will have an opportunity to inspect in all particulars the inner workings of this splendidly co-ordinated installation.

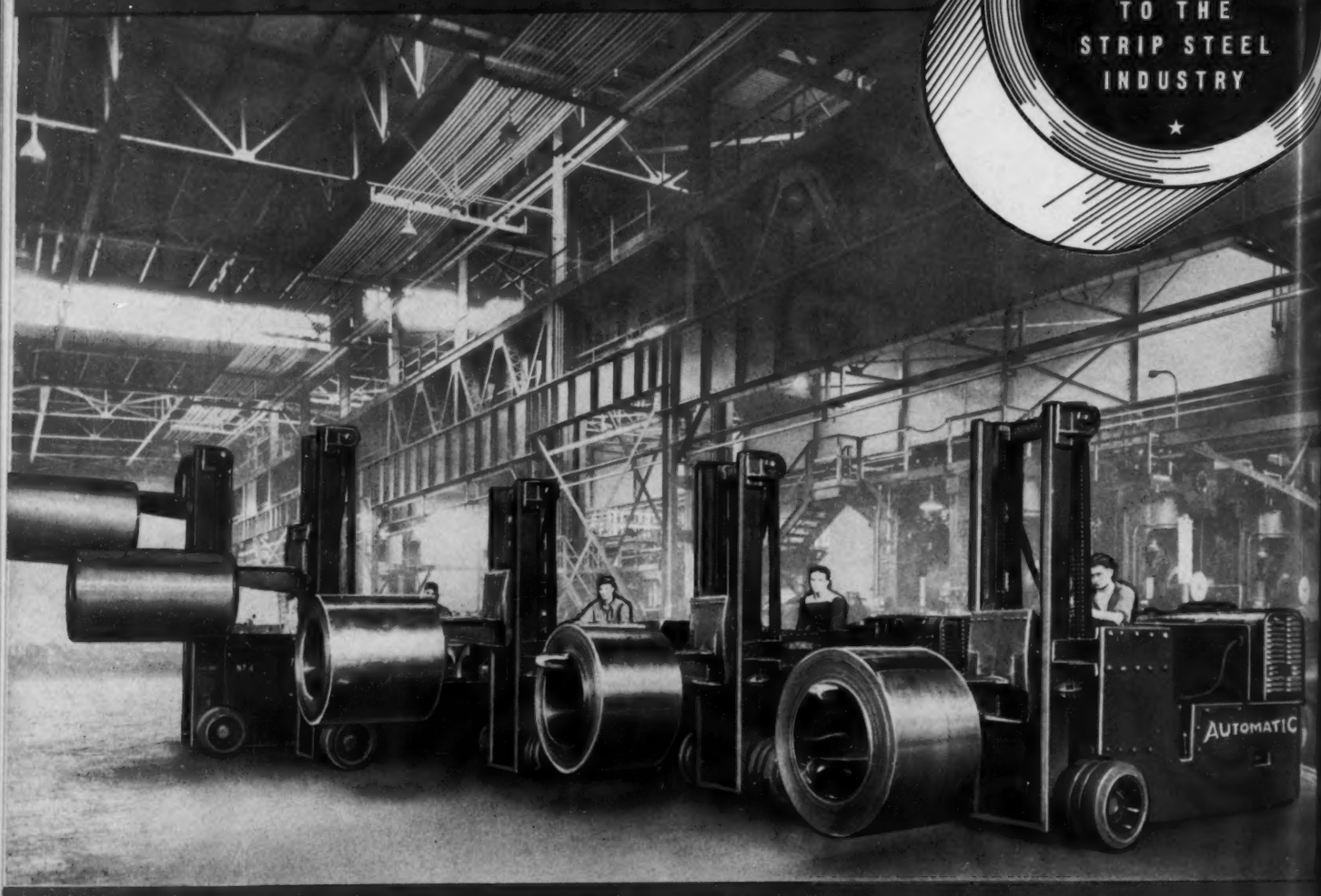
General Electric builds apparatus that you can depend upon from start to finish. For more than twenty-five years General Flectric engineers have been designing electric drives for steel mills. Continued progress has been made as the art advanced, and today General Electric, the largest manufacturer of electric equipment in the world, is proud to offer you the best that money can buy in complete electric equipment. From turbine (if you generate your own power) to auxiliary motors and control on the final processes, General Electric is prepared to install for you a properly balanced and co-ordinated equipment—flexible, easy to operate, and saving time, money, and labor for your company.

Let our steel-mill engineers assist you in planning your mill installation. G-E steel-mill equipment includes a-c and d-c motors and control, motor-generator equipment, switchgear, cable, protective devices, electric furnaces, and welding—in short, everything electric. Our specialists will be glad to help you. Call the nearest G-E office or write our home office. We cordially invite you to visit the G-E exhibit at the Steel Convention. General Electric Company, Schenectady, N. Y.

E L E C T R I C

AUTOMATIC
COIL HANDLING TRACTORS

A MODERN CONTRIBUTION TO THE STRIP STEEL INDUSTRY



IN SERVICE AT THE NEW

GREAT LAKES STRIP MIL

SEE THESE "AUTOMATICS" AT THE IRON and STEEL EXPOSITION DETROIT
SEPT. 22 TO 25 INCLUSIVE
BOOTHS 148 — 149 — 150

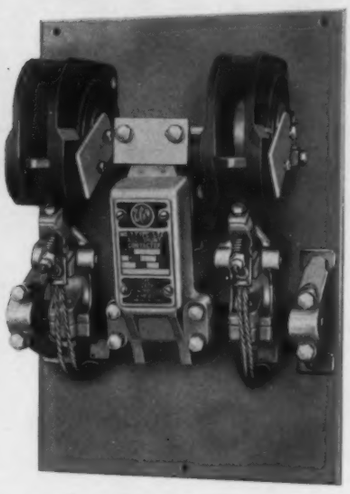
★ A vital part of the new continuous strip steel process are the facilities for co movement throughout the mill. From continuous pickler to rotary shears, storag or cold roll, these "AUTOMATIC" HEAVY DUTY, FRONT WHEEL DRIVE, CENTE CONTROL RAM TYPE TRACTORS illustrated are keeping step with productio schedules in the most modern strip steel coil mills in the country. Whether yo coils weigh 7,000 pounds or 30,000 pounds—36" to 93" wide, "AUTOMATIC" RA TYPE TRACTORS transport and stack these heavy coils of strip steel quickl safely, efficiently and at low cost.

E-C-M LINE-HRC CONTACTORS (TRADE MARK)

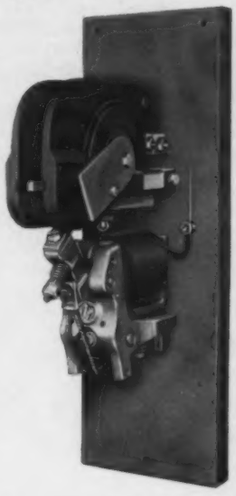
AUTOMATIC TRANSPORTATION COMPANY
DIVISION OF YALE & TOWNE MANUFACTURING CO.
47 WEST 87TH STREET CHICAGO, ILLINOIS

PIONEER MANUFACTURERS OF POWER TRUCKS - TRACTORS & CRANES

ON EXHIBIT
at the
IRON & STEEL EXPOSITION



A-C CONTACTOR



D-C CONTACTOR

Do not fail to see the EC&M Line-Arc Contactor display. Here will be an opportunity to actually observe the remarkable arc-handling ability of these Line-Arc Contactors. Not only will a standard contactor be demonstrated handling as high as 300% of normal load, but special plans have been made to secure both an A-C and a D-C Line-Arc Contactor which have been returned after having made more than a million operations on extremely hard service in the field.

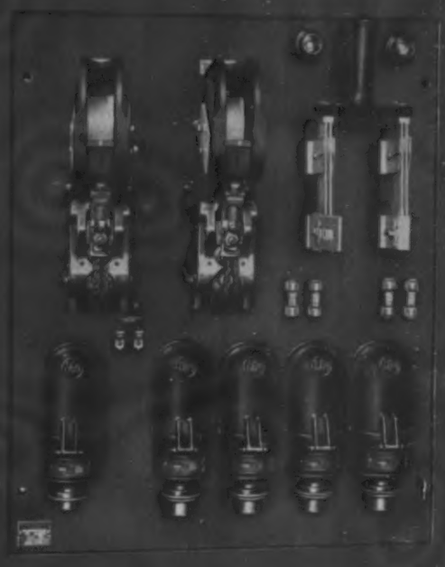
In addition, these EC&M Line-Arc Contactors will be shown as part of new Bulletin 1021-A Crane Protective Panels, Bulletin 920 Time-Current Controllers for crane and mill applications. Also in a NEW Mill Type Direct Current Starter and in Slip-ring and Primary-reactor Starters and Controllers.

VISIT BOOTH NOS. 7, 8 & 9

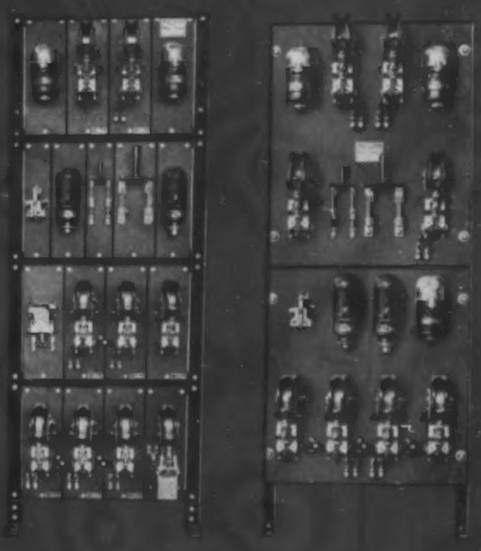
CONVENTION HALL

So. Cass Ave. • Detroit, Mich.

Used in



Crane Protective Panels



Crane & Mill Controllers

and in a NEW MILL TYPE D. C. STARTER

EC&M LINE-ARC (TRADE MARK) CONTACTORS

The ELECTRIC CONTROLLER & MFG. CO.

2700 East 79th St., CLEVELAND, OHIO — Offices and Agents in Principal Cities

HEAVY DUTY MOTOR CONTROL for.. BRAKES • LIMIT STOPS • LIFTING... E&M ...CRANES • MILL DRIVES and MACHINERY ...MAGNETS • and WELD TIMERS

GREAT LAKES...

EC&M BRAKES · LIMIT STOPS · RESISTORS

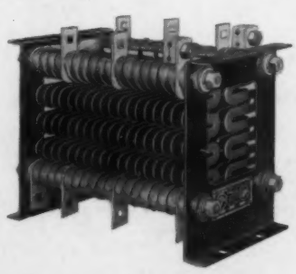
selects WB BRAKES

Also Youngstown Safety Limit Stops and Nickel Alloy Resistors

GREAT LAKES STEEL CORPORATION is one of four large steel mills to swing over to EC&M Type WB Brakes for their recent mill additions; nearly 100 WB Brakes being used on the new mill at Great Lakes.

The reason for this trend toward the EC&M Type WB Brake is due to the outstanding advantages of this shoe-type brake, the more important of which are:

1. ***Extra thick, molded brakeblocks made from a tough, wear-resisting material.***
2. ***Long wear before adjustment is necessary and only one adjustment to compensate for this wear.***
3. ***Adjustments very accessible and easy to make.***
4. ***Quick armature removal, when required, without disturbing the original adjustments.***



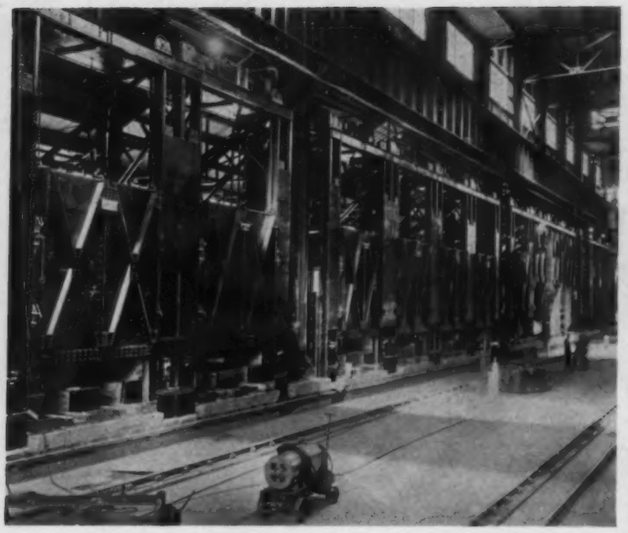
Of equal importance in keeping production running smoothly are EC&M Bulletin 1035-A Youngstown Safety Limit Stops and Bulletin 940-A Nickel Alloy Resistors. Each is an important part of the electrical equipment for the modern steel mill. Ask for copies of Bulletins describing them.

THE ELECTRIC CONTROLLER & MFG. CO.
Cleveland, Ohio

EC&M BRAKES • LIMIT SWITCHES • MASTERS

ANNEALING FURNACES « « «

» » » by Rust



Views of annealing furnaces designed and built by RUST for the Great Lakes Steel Corporation

In conjunction with the modernization program just recently completed at the Great Lakes Steel Corporation, the Rust Furnace Company designed and built 5 batteries of 4 double box length annealing furnaces.

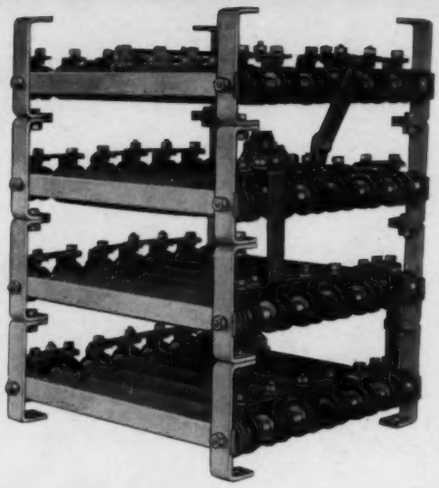
Designed to handle charges of coils and flats, they are oil fired and complete with fuel oil conditioning system. Well constructed, fully insulated, and equipped with temperature recording instruments, this type of annealing furnace and method of firing permits the use of light annealing covers which results in low fuel consumption and increased efficiency.

Rust Furnace Company

PITTSBURGH, PA.

Our Growth

1925



"You Can't Keep A Good Man Down!"

Neither can a good organization be kept from progressing in defiance of one of the worst business depressions.

Exceptional Engineering, Meritorious Manufacturing and Service with a Smile have brought the progressive results here pictured.

1929

An increase of four hundred per cent in Area from 1925 to 1936, just eleven short years, tells the story, emphatically, to the effect that Clark "3C" Products have met the demands of Industry in a manner most satisfactory.

We look forward to welcoming you at the IRON AND STEEL EXPOSITION in Detroit, where we will show some very interesting improvements, in "3C" Magnetic Brakes, Magnetic Contactors and Edgewound Resistors.

Look for the "Clark Tower".
Space Nos. 32, 33, 58 and 59

1930

1934

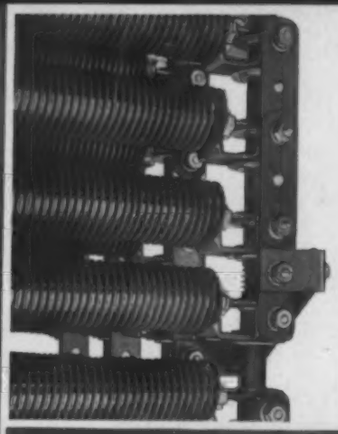
The CLARK CONTROLLER Co

1925-1936!

We announce an improved Clark Edgewound Non-Breakable Resistor.

The improvement includes a new welded terminal construction and wider spacing between sections. The welded terminal insures a permanently perfect connection.

The wider spacing gives easier access to the entire bank and allows better air circulation for dissipating the heat.



Close-Up View of Welded Terminal

The terminal is copper strip welded direct to the edge of the resistance metal and firmly supported by the frame.

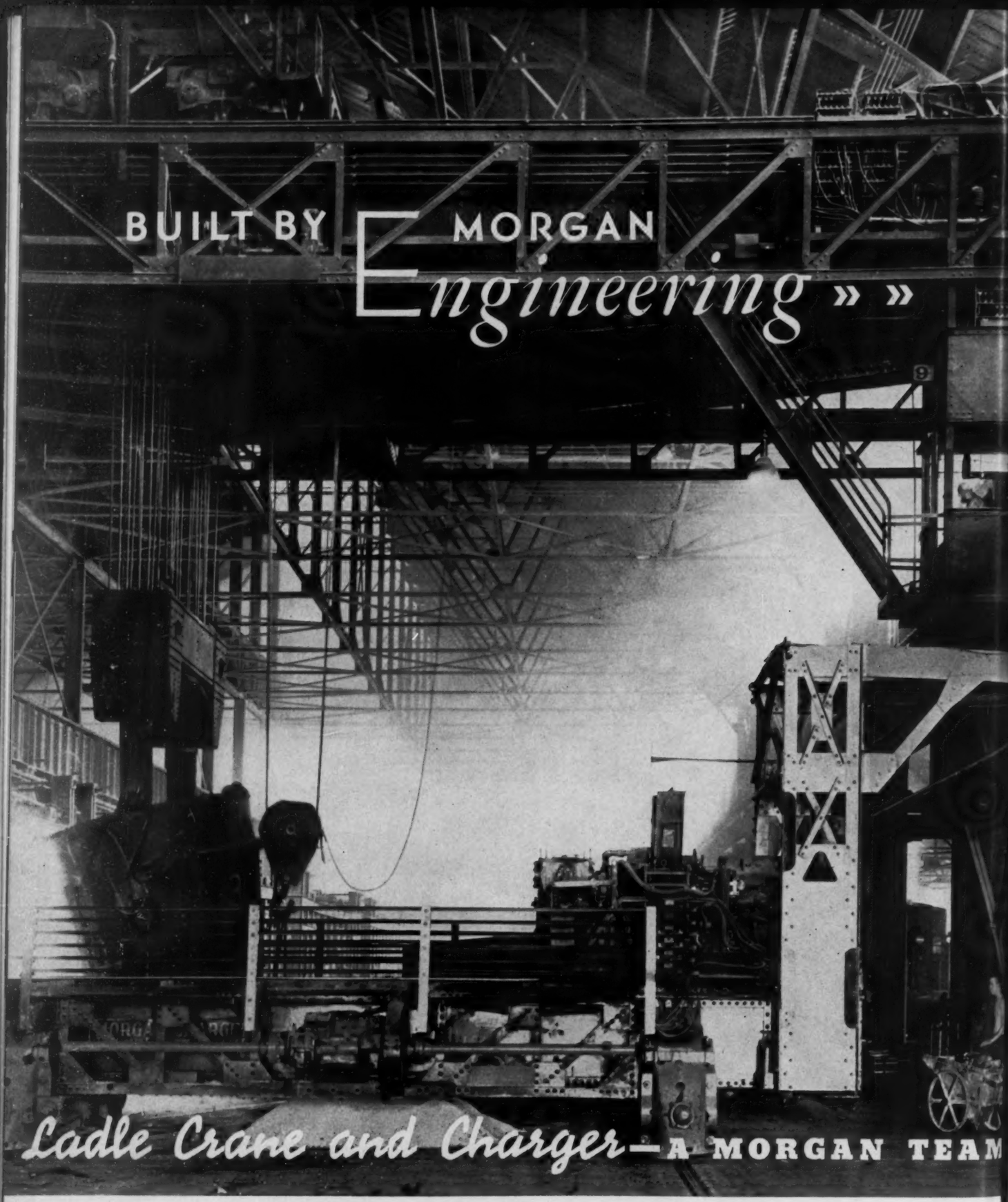
This construction is used only on Resistors built for separate mounting.

One of the inspection trips planned for the Iron and Steel Engineers will present an opportunity to see an exceptionally modern Steel Mill which is practically 100% equipped with Clark "3C" Edgewound Resistors.

1935

1936

Co 1146 East 152nd St. CLEVELAND, OHIO



● Here is a Morgan 125-ton, 86′0″ span, 4-girder type hot metal crane and a Morgan 7½-ton, 22′8″ span, floor charger at work side by side in a great steel plant in the Detroit district. This large steel producer operates 54 Morgan cranes of various types, ranging in capacity from 7½ tons to 250 tons. Since dependability of operation is the prime requisite of steel mill machinery, it is a source of great pride to Morgan Engineering that most of the large steel-making plants operate not one, but many cranes bearing the Morgan name-plate. But greater than the feeling of pride is the sense of responsibility that such an evidence of confidence places upon Morgan men, with a reputation for integrity.

★

★ DESIGNERS • MANUFACTURERS • CONTRACTO

★ BLOOMING MILLS • PLATE MILLS • STRUCTURAL MI

ELECTRIC TRAVELING CRANES • CHARGING MACHIN

★ INGOT STRIPPING MACHINES • SOAKING PIT CRA

ELECTRIC WELDED FABRICATION • LADLE CRA

★ STEAM HAMMERS • STEAM HYDRAULIC FORGI

PRESSES • SPECIAL MACHINERY FOR STEEL MI

★ THE MORGAN ENGINEERING CO., Alliance, O

Pittsburgh, 1420 Oliver Bldg. New York, 11 W. 42nd St

★

With safe
truction,
dle crane
onomical
e Morga
hen Morg
t the stee
ch heavy
ndards o

Hot Metal Cranes AT GREAT LAK L

With safety inherent to design and construction, Morgan Engineering builds ladle cranes that render a lifetime of economical, efficient service. No one in the Morgan organization can recollect when Morgan did *not* build ladle cranes for the steel industry. Pioneer builder of such heavy duty equipment, Morgan standards of integrity were founded more than 55 years ago when every crane built represented an engineering achievement. Today, with the accumulated experience of all these years, Morgan Ladle Cranes constructed by modern methods forecast even greater records for dependable service. This 250-ton, 60'0" span, 4-girder type ladle crane is equipped with worm operated trolley and anti-friction bearings.

★

★

DESIGNERS • MANUFACTURERS • CONTRACTORS

★

BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS
ELECTRIC TRAVELING CRANES • CHARGING MACHINES

★

INGOT STRIPPING MACHINES • SOAKING PIT CRANES
ELECTRIC WELDED FABRICATION • LADLE CRANES

★

STEAM HAMMERS • STEAM HYDRAULIC FORGING
PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

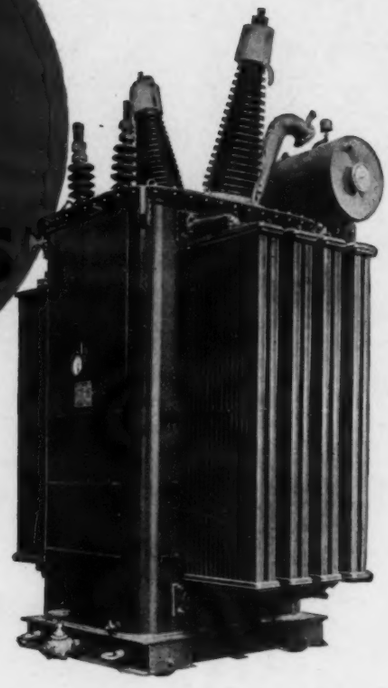
★

THE MORGAN ENGINEERING CO., Alliance, Ohio
Pittsburgh, 1420 Oliver Bldg. New York, 11 W. 42nd Street

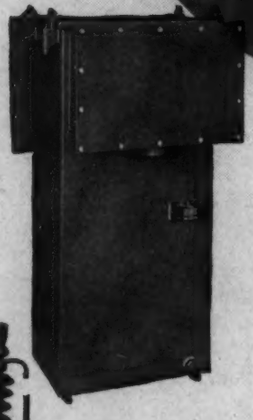
★

Distribution Transformers

FOR DEPENDABLE SERVICE USE Wagner Transformers



Power Transformers



Lighting Transformers

Auxiliary Power Transformers

Visit WAGNER BOOTHS No. 179-180 Iron & Steel Exposition Detroit, Mich. Sept. 22-25

WAGNER transformers are of sturdy construction and are liberally designed to withstand abuses and to operate at all times at high efficiency. They meet demands for reliable service under all conditions found in the steel industry.

The Wagner line includes every type and size of power and distribution transformers, enabling Wagner to supply all your requirements. Call on Wagner! Forty-five year's experience in the electrical field is at your disposal.

TT236-IT

Wagner Electric Corporation
6400 Plymouth Avenue, Saint Louis, U.S.A.

...ical C-H Mill Control ...balcony in Great ...es plant. Enclosed ...trol *at left*—A. C. ...sing side-guards ...trol. Open Board *at ...t*—screwdown con- ...for 6 finishing stands ...of mill.

75-25 ton crane in Great Lakes plant and run-out table—both completely equipped with C-H Control.

Cutler-Hammer Screw-down Control Panel for 6 motors of the No. 1 Tandem Cold Mill, Great Lakes Steel Corp.

C-H Bench Board for C-H Control on one of the pickling lines, Great Lakes Steel Corp.

FOR THE NEW MILL AT THE GREAT LAKES STEEL CORP.

UTLER-HAMMER MOTOR CONTROL

...or the Cutler-Hammer Control Installations when you ...e new mill of the Great Lakes Steel Corporation ...the Iron and Steel Exposition at Detroit. Some are ...ed here. Many others will be in evidence on your ...rough this modern plant. Such advanced, unified control . . . a genuine achievement . . . is typical of the engineering ability that will be brought into action on *your* requirements, no matter how new, large or complex. CUTLER-HAMMER, Inc., *Pioneer Manufacturers of Electric Control Apparatus*, 1269 St. Paul Ave., Milwaukee, Wis.

Look for the **CUTLER-HAMMER Exhibition Booths . . .**

where other items in the C-H line of modern Steel Mill Equipment will be on display.

68 73 127

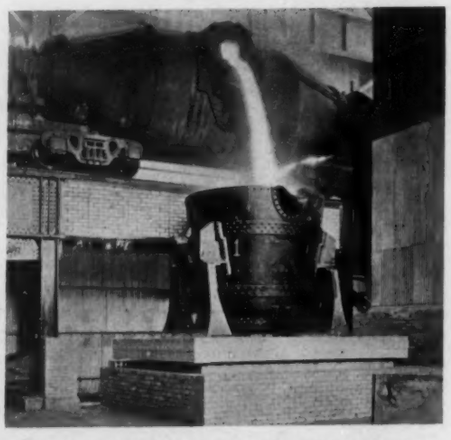
UTLER C-H HAMMER

OTOR CONTROL FOR MILL AUXILIARIES

TREADWELL

STEEL PLANT EQUIPMENT

Four 200 Ton Open Hearth Ladles

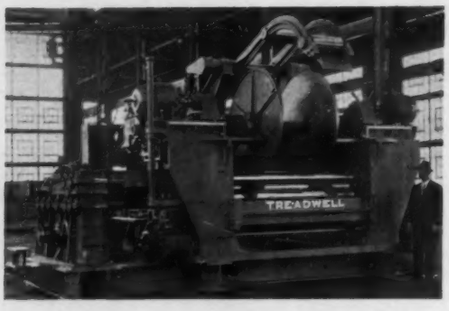


150 Ton Mixer Type Hot Metal Car and 70 Ton Transfer Ladle

Strip Pickling Equipment
Uncoilers
Up-cut Shears
Stitching Machines
Tension Reels

M. H. TREADWELL CO., INC.
140 CEDAR STREET,
NEW YORK

TREADWELL ENGINEERING CO.
EASTON, PENNA.

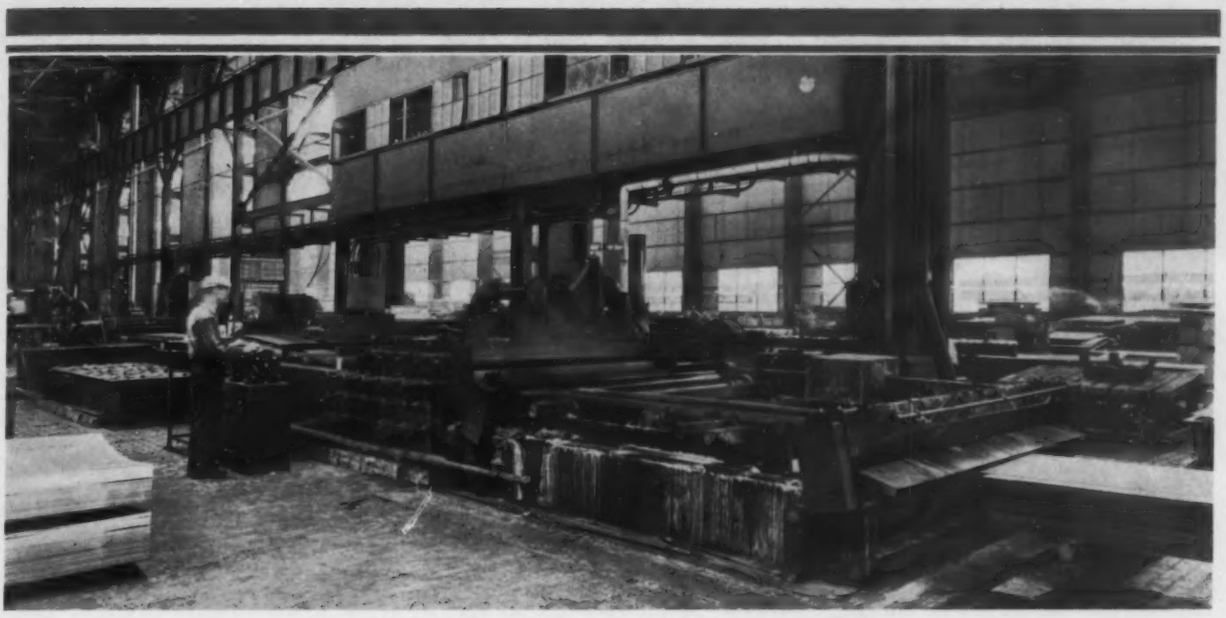


3-Roll Coiler for 80" Hot Strip

Cinder and Hot Metal Cars
Open Hearth Ladles
Cooling Beds
Steel Plate Construction
Special Machinery
Iron and Steel Castings

M. H. TREADWELL CO. OF ILL.
208 S. LASALLE STREET
CHICAGO

TREADWELL CONSTRUCTION CO.
MIDLAND, PENNA.



90" Cleaning, Scrubbing and Drying Line

AT GREAT LAKES STEEL CORPORATION

COMPLETE EQUIPMENT

for

The finishing end of Strip Mills,
Tin Mills and Sheet Mills
Rolling Mill Machinery
Roll Lathes
Straightening Machines
Stretcher Levellers
Spike Machines
Tube Mill Equipment
Special Machinery
Shears

We operate a large iron foundry, making castings up to 100,000 lbs. We specialize in Alloy Irons, of which some were developed by us and are identified as Paralloy. This embraces Nickel, Chrome and Molybdenum Alloys with a proper base mixture to secure consistent results, deliver high strength, improved toughness, maximum machinable hardness, and ready response to heat treatment. This has a special advantage for forming dies or other castings that require resistance to abrasion.

Sand and Chilled Rolls - - - Youngstown Special Alloy Rolls

The YOUNGSTOWN FOUNDRY & MACHINE CO.

YOUNGSTOWN, OHIO

1886 - FIFTY YEARS OF SERVICE TO THE STEEL INDUSTRY - 1936

An Invitation

TO THE

STEEL ENGINEERS

of AMERICA

If you would like to see the latest developments in boiler combustion control, and metallurgical furnace control . . .

If you would like to know about the up-to-the-hour work being done with boiler water to guard against embrittlement, scale and corrosion . . .

If you would like to see how and why Hagan-Hall Dual Service protects both the firing and the steaming surfaces of your boilers . . .

We invite you to visit us at the Iron and Steel Exposition in Detroit, Michigan, September 22-25, 1936, Booths No. 195, 196 and 197.

HAGAN

AUTOMATIC COMBUSTION CONTROL

THE PIONEER

3 Outstanding Control Installations (among 3000 others) Entrusted to HAGAN Engineering

★ CHEVROLET

In 1926, ten years ago, Chevrolet Motor Company's Forge Plant at Detroit, with a steam power plant of five boilers, well designed for that time and that load, chose Hagan Combustion Control. Today Chevrolet is modernizing by expanding its power plant through the building of a new power house, with two new pulverized coal-fired boilers operating at 180,000 pounds per hour at 700 pounds steam pressure.

These new boilers presented a combustion control problem entirely different from that of the older plant.

But the old Hagan Control had functioned perfectly. It was realized that the latest-type Hagan Control was fully in step with advances in boiler design.

So, in its modernizing plans, Chevrolet naturally turned again to Hagan for the combustion control of its new power plant.

★ BUICK

Buick Motor Company at Flint, Michigan—another important unit of General Motors, modernizing to meet growing steam needs, is building a new power house. The four new boilers, now being installed, will give more steam, speed production of cars, lower production costs.

The economical and efficient control of the combustion of fuel and air in these new boilers, Buick realized, is just as important as the expansion of the power plant itself. Considerable thought and time were given the problem. Control systems of other boiler plants were studied. In the end, the decision was made to equip the four new boilers with Hagan Combustion Control.

★ GREAT LAKES STEEL

Hagan Combustion Control has been selected for the three new boilers of Great Lakes Steel at Detroit, important unit of National Steel.

These new boilers, being installed at Hanna Furnace Division of Great Lakes Steel, on Zug Island, are combination-fired with blast furnace gas and oil, operating at 425 pounds pressure and 700° temperature.

The Great Lakes Steel Installation by Hagan follows by a few months the purchase by its sister organization, Weirton Steel, of complete Hagan Combustion Control for its two new 400,000 pound boilers at Weirton, West Virginia.

★ ★ ★

THE selection of Hagan Combustion Control by such outstanding steel groups as Great Lakes Steel and Weirton Steel—as well as Chevrolet and Buick of General Motors—indicates recognition of the superiority of Hagan engineering ability and experience.

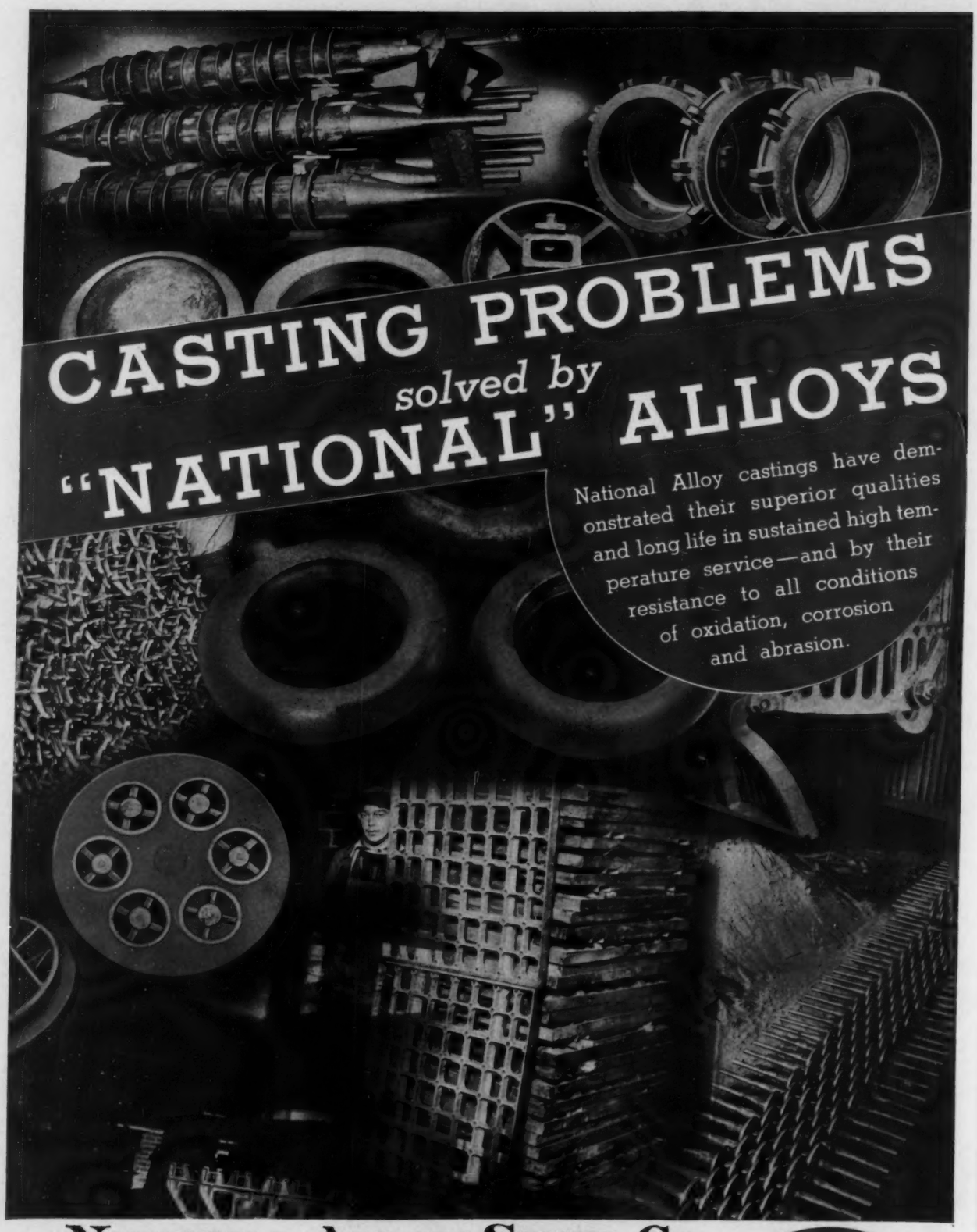
That four of the most important boiler plant installations in America within the past six months rely upon Hagan for combustion control means something to the engineers of industry.

HAGAN CORPORATION

Hall Laboratories, Inc. The Buromin Company
Subsidiaries

PITTSBURGH · PENNSYLVANIA

STILL LEADS


CASTING PROBLEMS
solved by
"NATIONAL" ALLOYS
National Alloy castings have demonstrated their superior qualities and long life in sustained high temperature service—and by their resistance to all conditions of oxidation, corrosion and abrasion.

NATIONAL ALLOY STEEL CO.

BLAWKNOX, PA.

Branches and Distributors

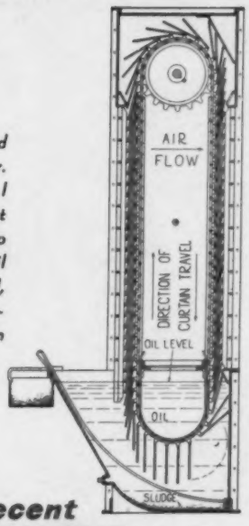
New York · Detroit · Pittsburgh · Chicago · Birmingham · Horace T. Potts Co., Philadelphia, Pa.

NA

Choose Wisely!

"INDEPENDENT"

AIR FILTERS ARE SPECIFIED BY LEADERS



Cross-section end view of filter. Sludge removal only necessary at intervals of two to six months. Oil never changed, merely replenished—consumption negligible.

Exacting conditions demanding automatic filtration and unvarying air flow are definitely and economically met by the outstanding and carefully engineered features of the INDEPENDENT DOUBLE DUTY.

The filtering principle of the DOUBLE DUTY is that of true impingement on viscous coated metal surfaces. It is entirely self-cleaning regardless of the dust content of the air. Self-draining design of the curtain plates eliminates all danger of oil entrainment. Double-pass efficiency and constant air delivery are assured by the non-clog and two way travel of the all steel louvre filter plates, with their rasp-like surfaces.

DOUBLE DUTY is unquestionably the leader in the field of heavy-duty installations with a wide range of industrial applications, due to high operating efficiency and maintenance economy.

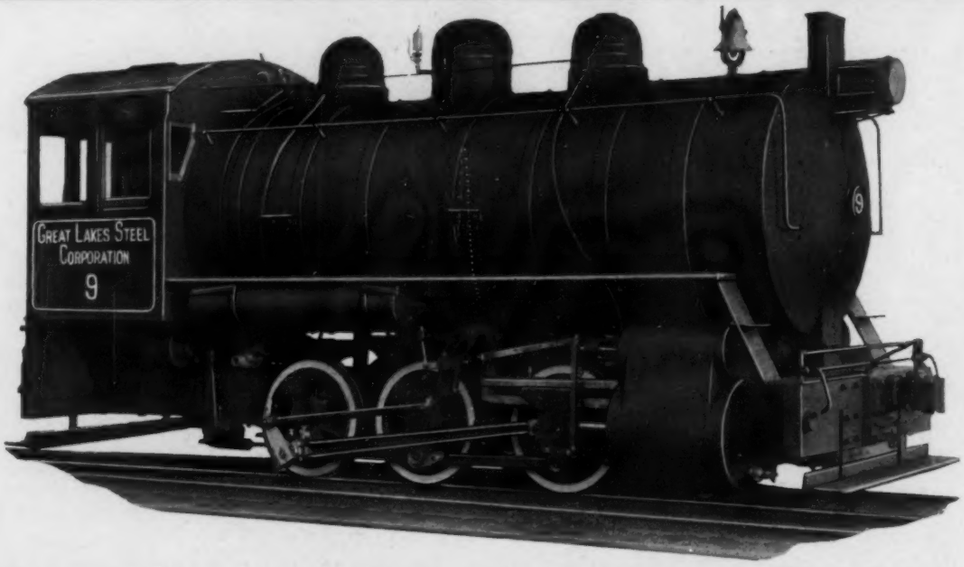
Model "L" may be had in sizes ranging from single sections of 5000 cfm. up to combination groups with a capacity as high as 600,000 cfm., such as recently installed in the new Carnegie-Illinois Steel Corporation mill at McDonald, Ohio.

There is an INDEPENDENT filter for every purpose.

A few recent INDEPENDENT installations

Great Lakes Steel Co.
Ford Motor Company
Carnegie-Illinois Steel Corp.
American Sheet & Tin Plate Co.
Inland Steel Co.
Bethlehem Steel Co.
Illinois Steel Co.
Republic Steel Co.
Wheeling Steel Corp.
Youngstown Sheet & Tube Co.
Stora Kopparsberg, Falun, Sweden.

INDEPENDENT AIR FILTER COMPANY
215 WEST OHIO STREET, CHICAGO, ILLINOIS



For 21 Years PORTER FIRELESS STEAM LOCOMOTIVES have led the World in Economy . . . Performance . . . Efficiency . . . Safety.

SEE IT IN ACTION—at the Great Lakes Steel Corporation during your Inspection Tour of their plant . . . check its remarkable record in service . . . note how smoothly and silently it runs . . . how handy it is for inside as well as outside plant duty, due to its smokeless fireless operation—then you can appreciate the profitable possibilities of the **Porter Fireless** in your plant.

H. K. PORTER COMPANY

Established 1866 . . . PITTSBURGH, PENNSYLVANIA

A new illustrated Bulletin of interesting facts and figures about the Porter Fireless Locomotive—including the remarkable Porter **Geared** Fireless—will be mailed on request.

PORTER
"better built"
locomotives

PORTER PIONEERED *the* FIRELESS
21 years of intensive construction and operation experience in every major industry is back of every Porter Fireless Locomotive.

USED THROUGHOUT THE UNITED STATES FOR 21 YEARS

"EXCELLENT COMMUTATION"

IS THE VERDICT OF STEEL MEN WHO INSPECT THESE WESTINGHOUSE COLD MILL MOTORS!

Installed in the
GREAT LAKES STEEL CORPORATION PLANT
AT ECOURSE, MICHIGAN

Operating side of #1 tandem mill. A 1250-horsepower motor drives each of the three stands. Control on any one stand controls all three stands. Reel motor control automatically maintains proper tension on sheet.

★

When at Great Lakes notice the excellent commutation of the Westinghouse d-c. motors and generators. This means lower maintenance costs, fewer shutdowns and more steel rolled per hour . . . all of which helps keep costs down!

For fifty years Westinghouse has realized the importance of paying particular attention to details in order that the complete equipment may perform with maximum efficiency.

J 20157

Westinghouse

WESTINGHOUSE 1886 W 1936 GOLDEN JUBILEE

★

In

GREAT LAKES and FORD Installations

548 "TOOL STEEL" ROLLS

were used

Also crane track wheels and gears

We "DESIGNED" modern oils

... to meet modern Strip Mill Design

Extreme purity... quick separation...are essential

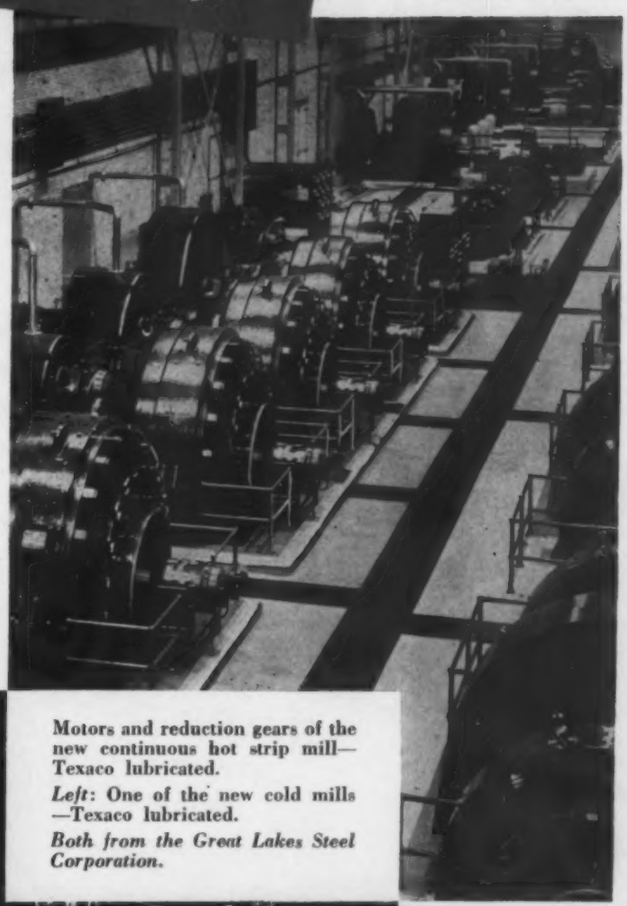
MODERN continuous strip mills must have a lubricant that is as pure and stable as a turbine oil.

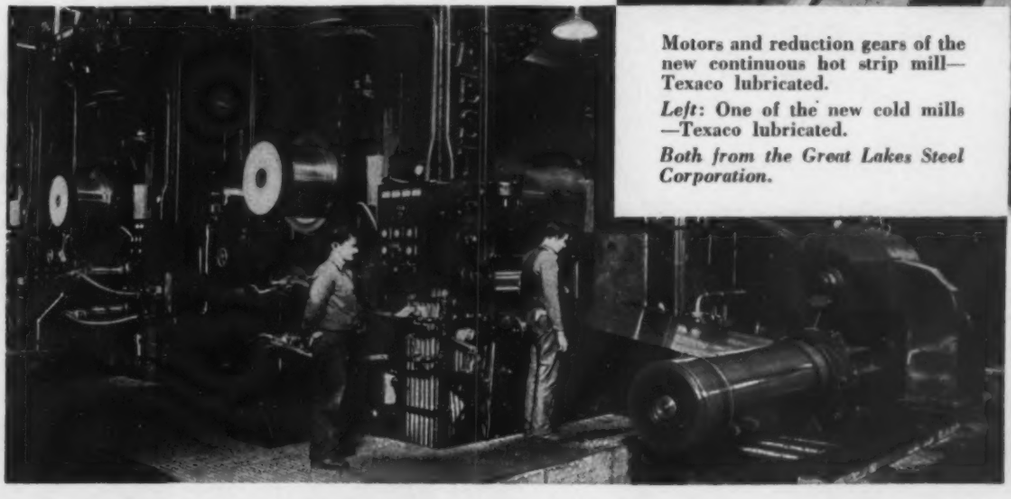
The New Texaco Regal Oils J and K are made particularly to meet the lubricating requirements of this most modern steel manufacturing equipment. These oils are made from selected crude, by special Texaco processes that remove all the harmful sludge forming elements.

Texaco Regal Oils J and K separate readily from water and other impurities and are easily filtered. They successfully withstand the temperatures and pressures met in continuous strip mill lubrication.

A Texaco representative will be glad to provide practical engineering service to prove the quality of these products.

THE TEXAS COMPANY
135 East 42nd Street · New York City
Nation-wide distribution facilities assure prompt delivery





Motors and reduction gears of the new continuous hot strip mill—Texaco lubricated.

Left: One of the new cold mills —Texaco lubricated.

Both from the Great Lakes Steel Corporation.

TEXACO

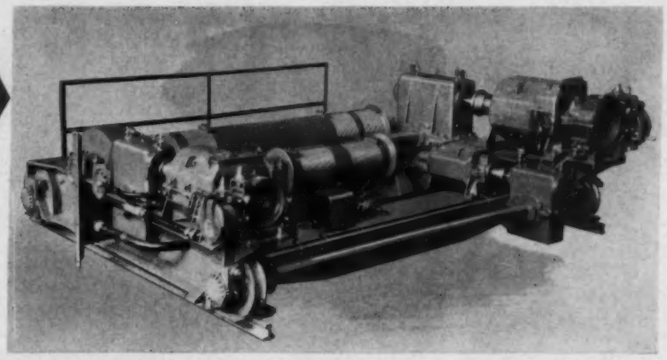
TEXACO *Industrial Lubricants*

Watch for the CLEVELAND WORM GEAR DRIVES

As You Go Through Great Lakes Steel

Watch for THEM

overhead: on the stripper, hot metal, ladle, soaking pit, stockhouse and general purpose cranes.

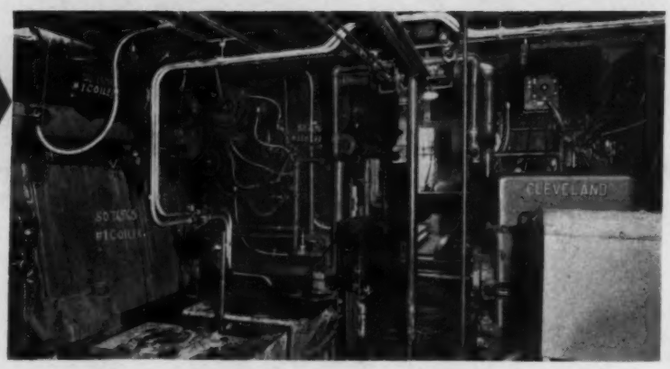


Watch for THEM

on the floor all around you: on the screw downs, manipulators, furnace pushers, pilers, skid beds, hot saws, vertical edgers, run out tables, levelers, pinch rolls, etc.

Watch for THEM

below the floor line: on the coilers, valve controls, door lifts, conveyors, tilters, etc.



•

Many of those you find will be in our standard cast iron or cast steel housings. Others will be incorporated as an integral part of the machinery—built into the machine housing, out of sight.

The numerous Cleveland Worm Gears to be found in the new mills can mean only one thing: complete satisfaction with those in the old.

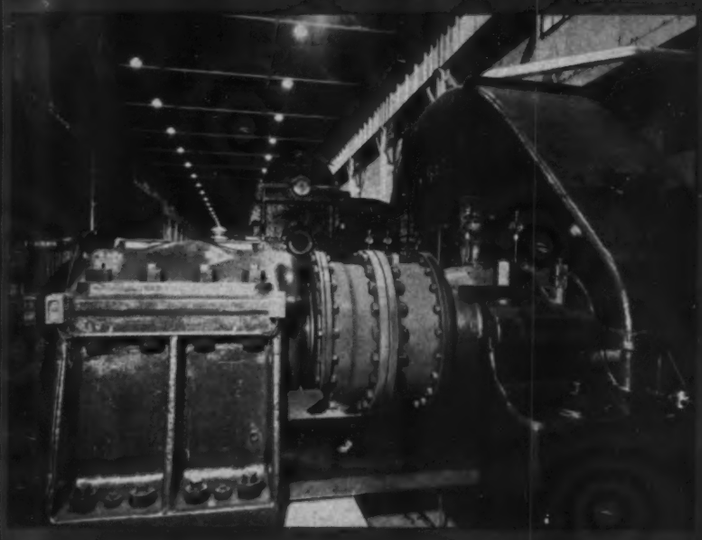
We are honored by having Cleveland Worm Gears selected for so many places that are vital to the successful operation of this steel plant. The Cleveland Worm & Gear Company, 3278 East 80th Street, Cleveland, Ohio.

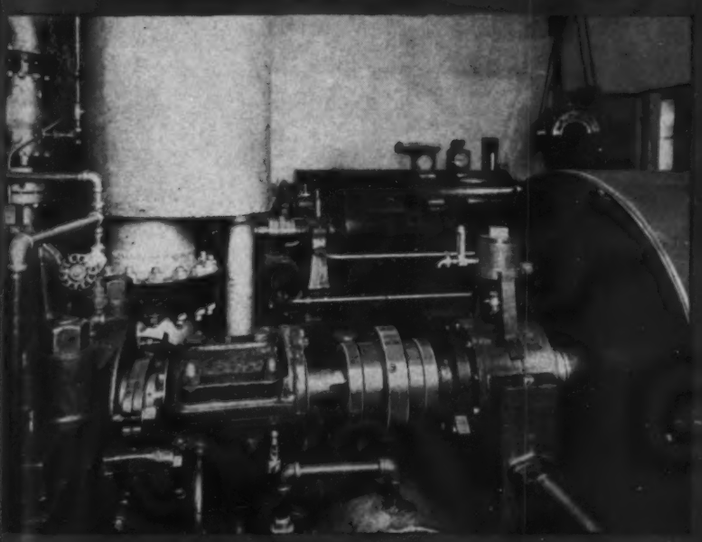
Affiliate: The Farval Corporation, Cleveland, Manufacturers of Centralized Systems of Lubrication

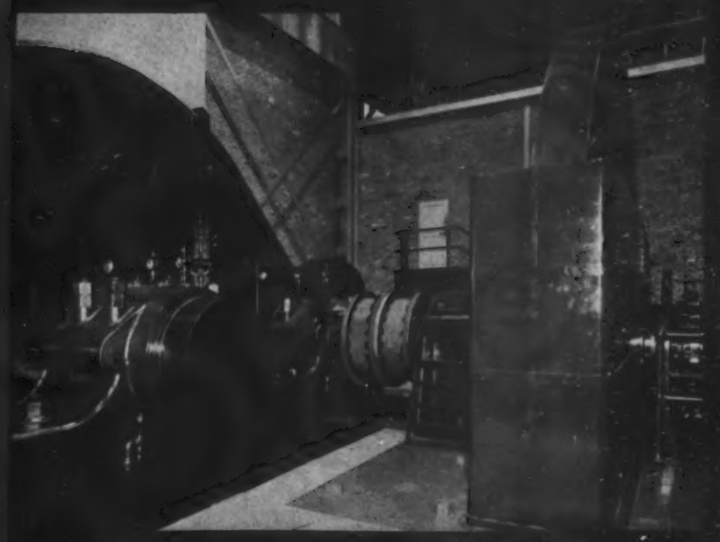
★ CLEVELAND *Worm Gear Drives*

Experience

Leads to the use of
Fast's Couplings







The Great Lakes Steel Corporation, like other leaders in the steel industry, equipped their new mill with genuine Fast's Self-Aligning Couplings.

The Bartlett Hayward Company
Baltimore, Maryland

PEAK STEEL PRODUCTION REACHED on Standard Conveyors

Many steel mills where production has broken all-time records this year are users of STANDARD ROLLER CONVEYORS.

Experienced engineers have perfected their design and construction so that no condition in the modern steel mill is too tough for Standard Equipment.

A visit to our booth at the Iron and Steel Exposition from September 22 to 25 will show you why Standard Conveyors are so popular in Steel Mills.

Catalog No. I-9 will be sent on request.

Complete information on steel mill conveyor equipment will be available at

Booth No. 37

STANDARD
CONVEYOR COMPANY
NORTH ST. PAUL, MINNESOTA
INCORPORATED IN 1906

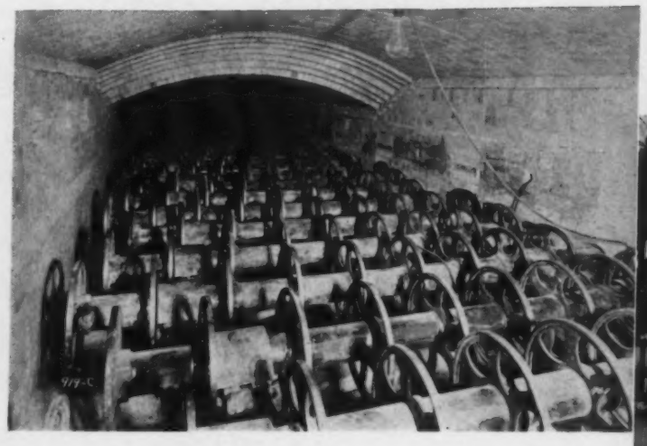
Sales and Engineering Offices located in 54 Principal Cities.

on your inspection trip through the

GREAT LAKES STEEL
HOT STRIP MILL

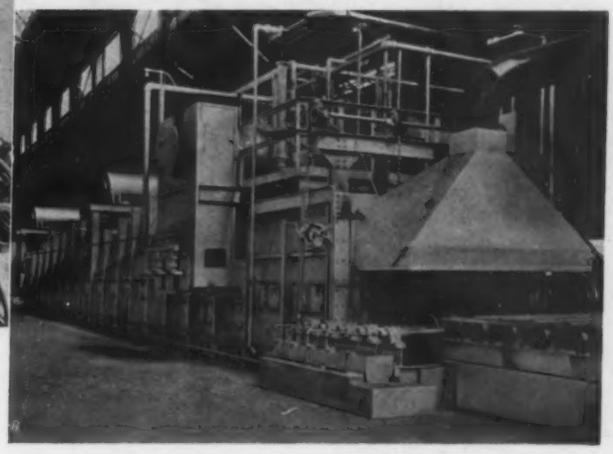
See

THE WIDEST DRY-SHAFT NORMALIZING FURNACE in operation . . .



← Inside View

Outside View ↓



See

THE DRIVER-HARRIS "Blythe" INSIDE ROLLER-BEARING SHAFT* in (Booths 46-47)

IRON AND STEEL EXPOSITION

installed at

Inland • Granite City • Wheeling • Great Lakes • Republic • Jones & Laughlin

Furnaces by **SURFACE COMBUSTION CORPORATION**

Alloy by **DRIVER-HARRIS COMPANY**

HARRISON, N. J.

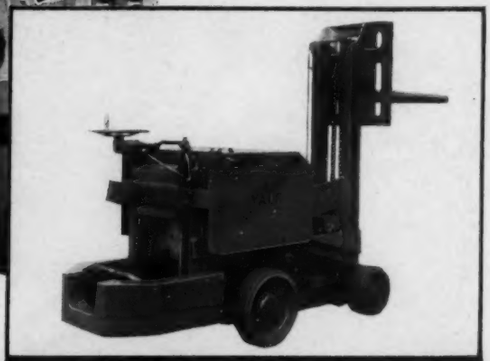
Chicago - Detroit - Morristown, N. J. - England - France
Cleveland Italy

OLDEST AND LARGEST MAKERS OF HEAT-RESISTING ALLOYS

*Covered by U. S. Patents.

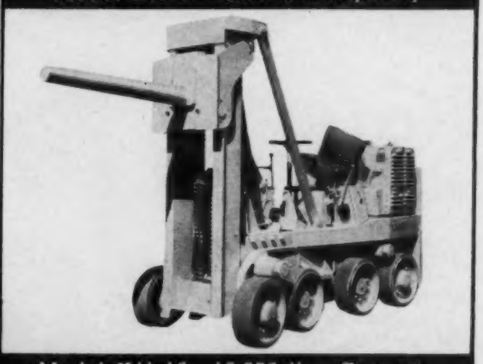
REDUCE HANDLING COSTS up to 80%

WITH YALE RAM TRUCKS



Model K30-5—5,000 lbs. Capacity

Model K41-8—8,000 lbs. Capacity



Model K41-16—16,000 lbs. Capacity

Eight-wheel steer—Four-wheel drive—Power and manœuverability for handling loads up to 20,000 pounds.

Yale builds a complete line of trucks of every conceivable type and capacity for all classifications of materials handling.

A Yale engineer, thoroughly familiar with handling problems, will gladly call at your request and recommend the equipment that will produce the greatest earnings for you.

The nearest Yale representative is no further away than your telephone.

TRADE YALE MARK

THE YALE & TOWNE MFG. CO.
PHILADELPHIA DIVISION—PHILADELPHIA, PENNSYLVANIA

SCHLOEMANN

MOTOR-ROLLERS
(Schulte and other Patents)
You can avoid delays to your mills and high cost of maintenance of mill table by using our self-contained, fool-proof Motor-Rollers.

SCHLOEMANN
ENGINEERING CO
Rolling Mill Machinery
PITTSBURGH, PA.
Hydraulic Presses

MIGHTY *Ram Trucks* *by* ELWELL-PARKER . . . .

Continue the Savings that Modern Production Machinery Began

● Since continuous Mills are effecting great economies in producing strip, the transfer or handling of coils between operations certainly merits Management's best thought in selecting Elwell-Parker Trucks to effect equal or even greater savings.

For more than a quarter-century, Elwell-Parker has helped the steel industry to effect progressively greater economies for itself, by reducing costs of tonnage-handling. Revolutionary methods of steel production have necessitated corresponding changes in design and size of material-handling equipment.

For big plant loads, Elwell-Parker builds big Trucks —standard or special models. If Elwell-Parker Engineers find conditions demand a new type of Truck or new attachments to existing models, they will design to suit conditions.

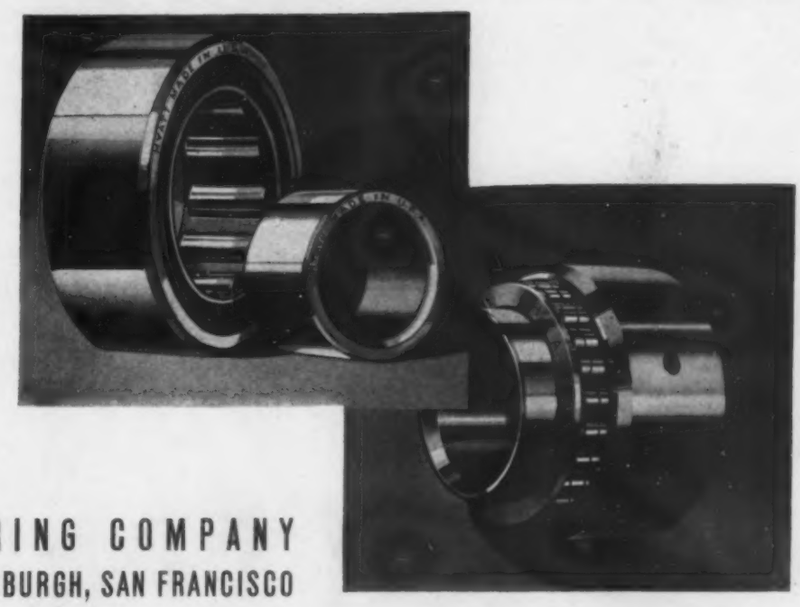
We will gladly send an Elwell-Parker Engineer who really knows steel, for consultation with you. If it appears that a new System could save you enough to amortize the investment readily, he will help you or your Engineers plan an Elwell-Parker installation exactly adapted to your needs. Elwell-Parker Trucks, 4504 St. Clair Avenue, Cleveland, Ohio.

New Type ELWELL·PARKER *Trucks*

ESTABLISHED 1893 • BUILDING POWER INDUSTRIAL TRUCKS SINCE 1906

When it's a TOUGH ASSIGNMENT
it's a job for
HYATT ENDURANCE

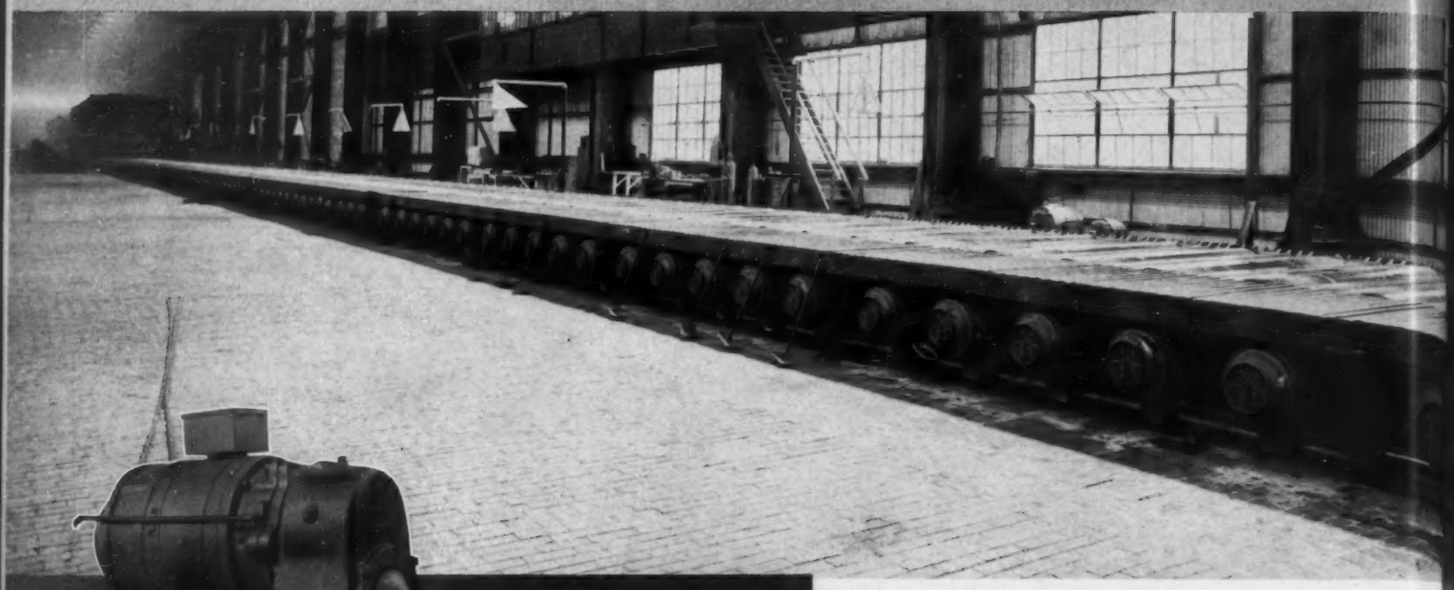
By virtue of the scope of its resources, the skill of its technicians, the profit of its experience, Hyatt produces the finest roller bearings. Bearings that endure the merciless punishment of speed, stress, and shock without perceptible wear. Bearings that defy the imagination in their matchless perfection. Husky bearings that keep related parts in permanent alignment. Bearings that serve longer and more efficiently, with the minimum of maintenance.



In the **GREAT LAKES STEEL CORPORATION** mill Hyatt Roller Bearings are everywhere. In the mill-tables—in the cranes and motors—in the cars and auxiliary equipment—Hyatts are saving and serving. Another example of Hyatt dominance as *the steel mill bearing.*

HYATT ROLLER BEARING COMPANY
NEWARK, DETROIT, CHICAGO, PITTSBURGH, SAN FRANCISCO

RELIANCE MOTORS .



Reliance Gearmotor for inverted mounting to run-out table rollers. Squirrel-cage, enclosed fan-cooled motor unit. To stand the severity of the service these gearmotors are constructed with cast-steel gear cases, heat-treated gears with unusually wide faces, special alloy-steel shafts.

Run-out tables for conveying strip from the mill to the coilers. Rollers are individually driven by enclosed, fan-cooled Reliance Gearmotors with a 3.55:1 ratio. These gearmotors operate on an adjustable frequency and voltage to provide table speeds over a 5:1 range. Quick stopping is obtained by direct current braking.

AFTER strip leaves the last finishing stand of the continuous mill, there is still important work to be done—hard work requiring rugged power units instantly responsive to changing needs. On run-out tables and coilers in the Great Lakes Steel Corporation Mill, Reliance Motors are doing these hard jobs. Reliance Engineers have made it their business to find out how these units can be designed, built, applied and controlled to best fit in with the ideas of the mill builders and the men who are responsible for producing the finished strip. It's a cooperative job and we have a background of experience which has prepared us for performing our part effectively.

Run-out table between coilers and gate shear. The squirrel-cage, enclosed fan-cooled Type "AA" Reliance Motors have special torque characteristics and are flange mounted. Each motor drives two rollers. Water from the sprays above the rollers is constantly splashing over these motors.

Water-cooled squirrel-cage Motor specially designed for direct connection to coiler rolls.

Below—Four 800 k.v.a. Reliance Motor-alternator Sets each driven by two 400 hp. 400-1200 r.p.m. d-c. motors. These sets supply current for operating run-out table motors at frequencies of 26/80 cycles.

One 120 k.v.a. set with two 60 hp. adjustable-speed d-c. motors supplying power at 26/80 cycles for a portion of the table synchronized with the flying shear.

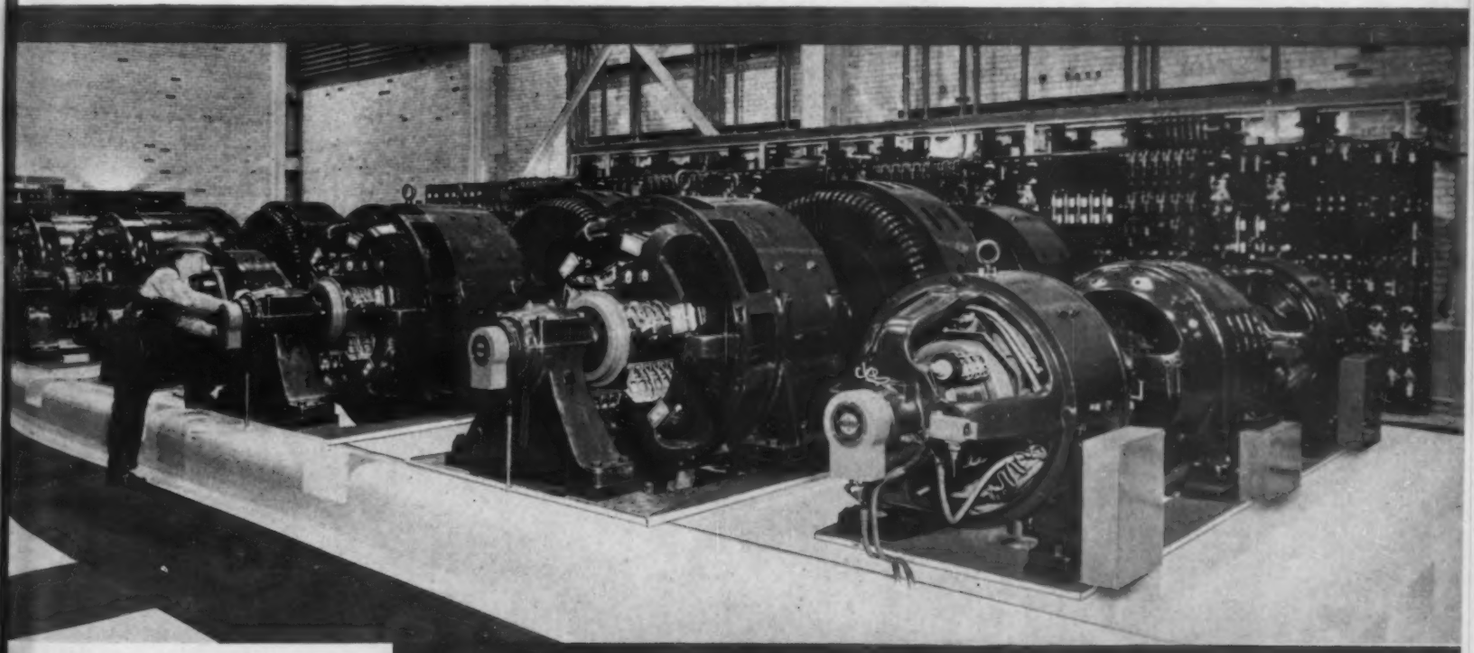
One 300 kw. synchronous motor-generator set which provides direct-current for dynamic braking. By means of the direct-current braking which is a patented Reliance feature, the table motors are stopped quickly and accurately.

RELIANCE ELECTRIC & ENGINEERING COMPANY

1088 IVANHOE ROAD, CLEVELAND, OHIO

Branches: Birmingham, Boston, Buffalo, Chicago, Cincinnati, Detroit, New York, Philadelphia, Pittsburgh

Representatives in other principal cities

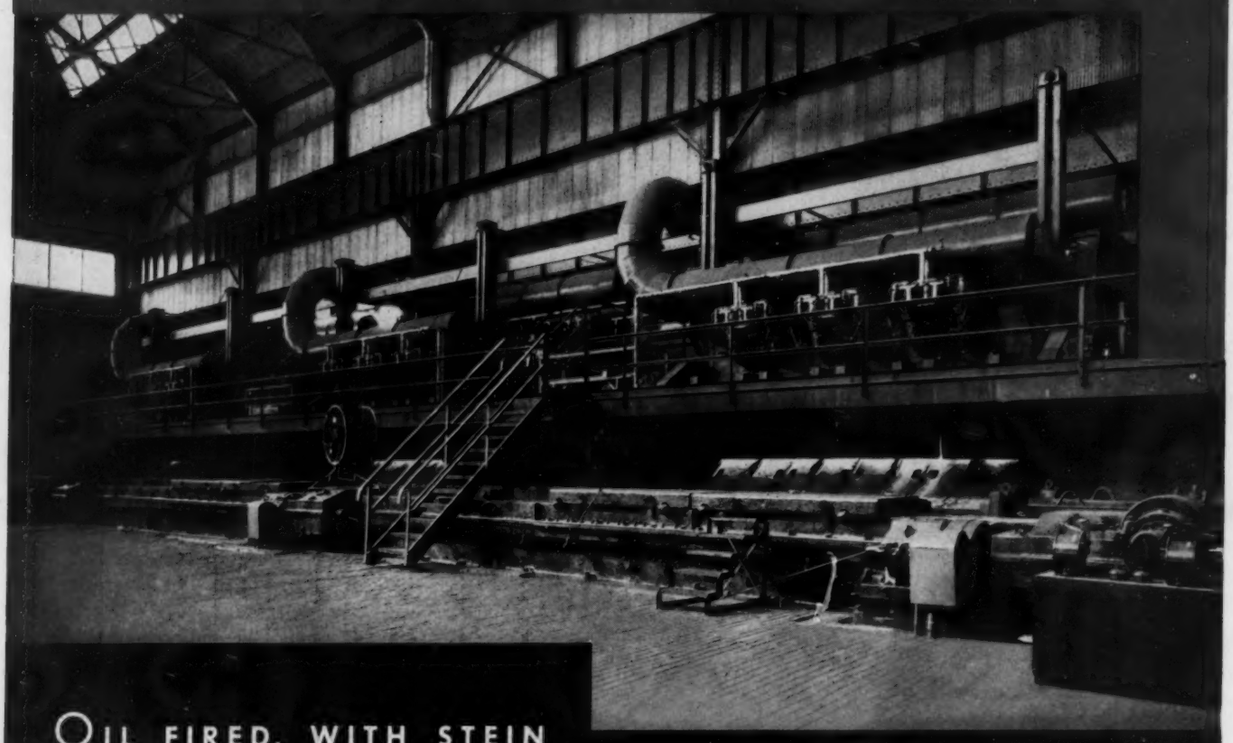


Reliance Motors are built with the determination that they must show a better-than average record in continuous, tough service in steel mills.

RELIANCE MOTORS

CONTINUOUS HEATING FURNACES

FOR BILLETS, SLABS AND ROUNDS



OIL FIRED, WITH STEIN REFRACTORY RECUPERATORS, AND ZONE CONTROL . . . ARE MEETING DEMAND FOR HIGH PRODUCTION RATE, EXACT UNIFORMITY, AND ECONOMY OF OPERATION AT

Great Lakes Steel

AND MANY OTHER MILLS

SC

THESE SC Continuous Slab Heating Furnaces at Great Lakes Steel provide a constant supply of slabs, uniformly heated to 2250° F. to the continuous strip mill. Here, as elsewhere, they have proved economical and dependable in operation.

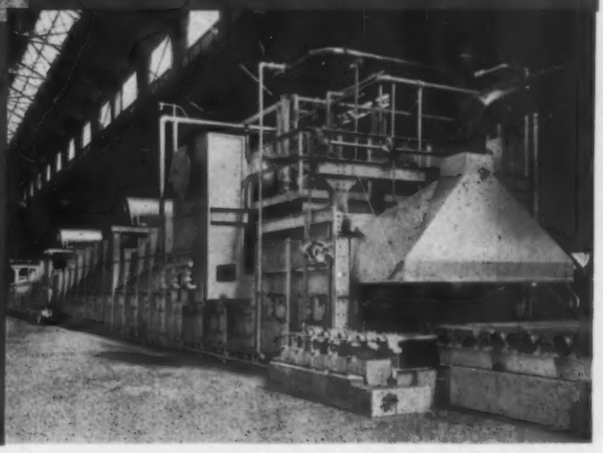
Surface Combustion continuous reheating furnaces are engineered by the Chapman-Stein division. Long experience of this personnel in steel plant operation provides the experience to build into these furnaces not only high thermal efficiency but exceptionally heavy construction to withstand the severe heavy duty to which such installations are subjected.

In steel mills everywhere, Surface Combustion is maintaining an enviable reputation for the best possible modern furnace development, design, engineering and construction.

SURFACE COMBUSTION CORPORATION, Toledo, O.

DISC TYPE SHEET NORMALIZING FURNACE

FIRED BY SC OIL GASIFICATION HAS ADVANTAGES OF GAS FURNACE . . . . EFFECTS MANY OPERATING ECONOMIES AND IMPROVES THE QUALITY AND UNIFORMITY OF NORMALIZED SHEETS



The SC Disc Type Sheet Normalizing installation at the Great Lakes Steel Hot Strip Mill pictured above utilizes the Oil Gasification method developed by Surface Combustion, by which heavy crude oil is actually converted into gas, giving the furnace all the advantages of gas heating.

This installation is said to be the widest dry shaft normalizing furnace in operation. It is equipped with a specially designed alloy shaft type conveyor and can be used both in normalizing and blue annealing. High speed travel of sheets through the cooling chamber is possible, irrespective of the rate of travel through the heating chamber. This is desirable in controlling the temperature at which blue annealed material is roller leveled.

Capacity, when normalizing 72 inch sheets of 18 gauge steel, is approximately 16,700 pounds net work per hour heated from cold to a maximum temperature of 1900° F. Capacity when blue annealing 72 inch sheets of 10 gauge steel, is approximately 38,000 pounds net per hour heated from cold to a temperature of 1650° F.

Grain growth in the sheets being normalized is controlled in the cooling chamber. Close, accurate temperature control in both the heating and cooling chambers is easily and automatically maintained. High quality and uniformity of production and many operating economies are assured. Write for further, more detailed information.

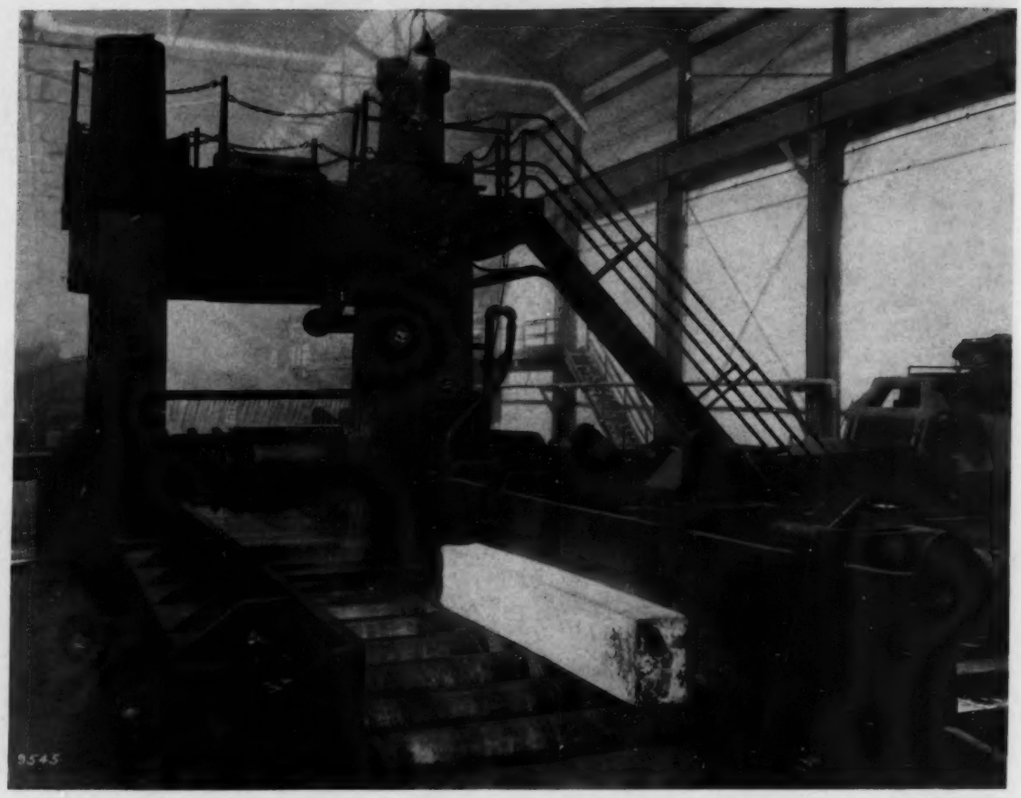
SURFACE COMBUSTION CORPORATION, Toledo, Ohio

Surface Combustion

Toledo, Ohio » *Sales and Engineering Service in Principal Cities*

Builders of ONE WAY FIRED SOAKING PITS » » BILLET HEATERS » » PACK OR PAIR, ANNEALING, CONTROLLED ATMOSPHERE FURNACES » » NORMALIZERS

MESTA



UNITS OPERATE ON

"NORMA-HOFFMANN" PRECISION BEARINGS

The 40" Blooming Mill here pictured—built by Mesta Machine Co. of Pittsburgh, for the Ecorse Plant of the Great Lakes Steel Corporation—employs A Single-Row NORMA-HOFFMANN PRECISION Ball Bearing with heavy-duty solid bronze retainer to take the thrust on each individual lineshaft for the Approach Table, Front Mill Table, Rear Mill Table, Mill Runout and Shear Approach Table, and Back Shear Table. * * * * In this same plant are a Mesta 20" Strip Mill with NORMA-HOFFMANN Ball Bearings on the lineshafts for the Furnace Charging and Furnace Delivery Tables; and a Mesta Billet Mill with a PRECISION Ball Bearing on the Approach Table lineshaft.

Engineers, designers and builders of heavy duty machinery find—in NORMA-HOFFMANN PRECISION BEARINGS—that extra-dependability which manifests itself in longer life, better performance, lower costs, and greater freedom from shut-down losses.

The NORMA-HOFFMANN PRECISION line includes 108 distinct series embracing over 3000 catalogued sizes—a PRECISION Bearing for every load, speed and duty. Write for the Catalog. Let our engineers work with you.

PRECISION BALL, ROLLER and THRUST BEARINGS

NORMA-HOFFMANN BEARINGS CORPN., STAMFORD, CONN. U.S.A.

POLLOCK

WELDED STEEL

HOT METAL HANDLING EQUIPMENT

. . . Can increase your production. Combining decreased dead weight with greater live load capacity, it necessitates no reinforcement or replacement in your existing plant. And in Pollock welded steel construction has been achieved the maximum of strength and durability.

The William B. Pollock Company

Steel Plate Construction **Youngstown, Ohio**

HUNT

(Quick-As-Wink)

MODERN HYDRAULIC DE-SCALING VALVE

Only one moving part-- No metal-to-metal wear. Absolute regulation of operating speeds--Opening Speed or Closing Speed independently controlled at will ---

POSITIVELY ELIMINATES WATER HAMMER

All water passages completely machined -- Extremely Low Pressure Drop -- Velocities through valve 20 per cent lower than pipe velocities.

Quick-As-Wink Pilot Valve used with De-scaling Valve—The pilot valve is the double solenoid high speed type—A recent Hunt Development. Burnouts are eliminated since Current "time-on" is the lowest that is possible—current being "on" but an instant for valve action or reversal—The Q. A. W. air control valve units are guaranteed against leakage—no metal-to-metal wear—give millions of operations without repair or leakage. Numerous combinations available for any air control job. Ask For Catalog "IS".

High Accessibility, Inspection and Re-Assembly in a few minutes—

INSTALLATIONS

Complete at McDonald, Lackawanna, Newport, Ky., Granite City, Ill., Detroit; Partial at Gary, Butler, Middletown. Details on Request.

Other Outstanding O. A. W. Products:— Air Control Valves—Guaranteed Leak-Proof. Hydraulic Valves—No metal-to-metal wear. Valve Couplings—Foolproof—Leak proof, Instant Operating. Hose Couplings, Roll Coolers.

C.B. HUNT & SON – SALEM, OHIO

lolophane

TEEL-CLAD

tandard HI-BAY

qhtinq Equipment

or Steel Mills

Standard HOLOPHANE HI-BAY Reflectors
Nos. 681-St, 691-St, 690-St, 692-St, 693-St.

Some Installations Made During the Past Year

Carnegie Illinois Steel Corp.
GARY

Carnegie Illinois Steel Corp.
HOMESTEAD

Bethlehem Steel Corp.
BUFFALO

Great Lakes Steel Corp.
DETROIT

Republic Steel Corp.
CLEVELAND

Inland Steel Co.
SOUTH CHICAGO

Youngstown Sheet & Tube Co.
YOUNGSTOWN

Jones & Laughlin Steel Corp.
SOUTH SIDE, PITTSBURGH

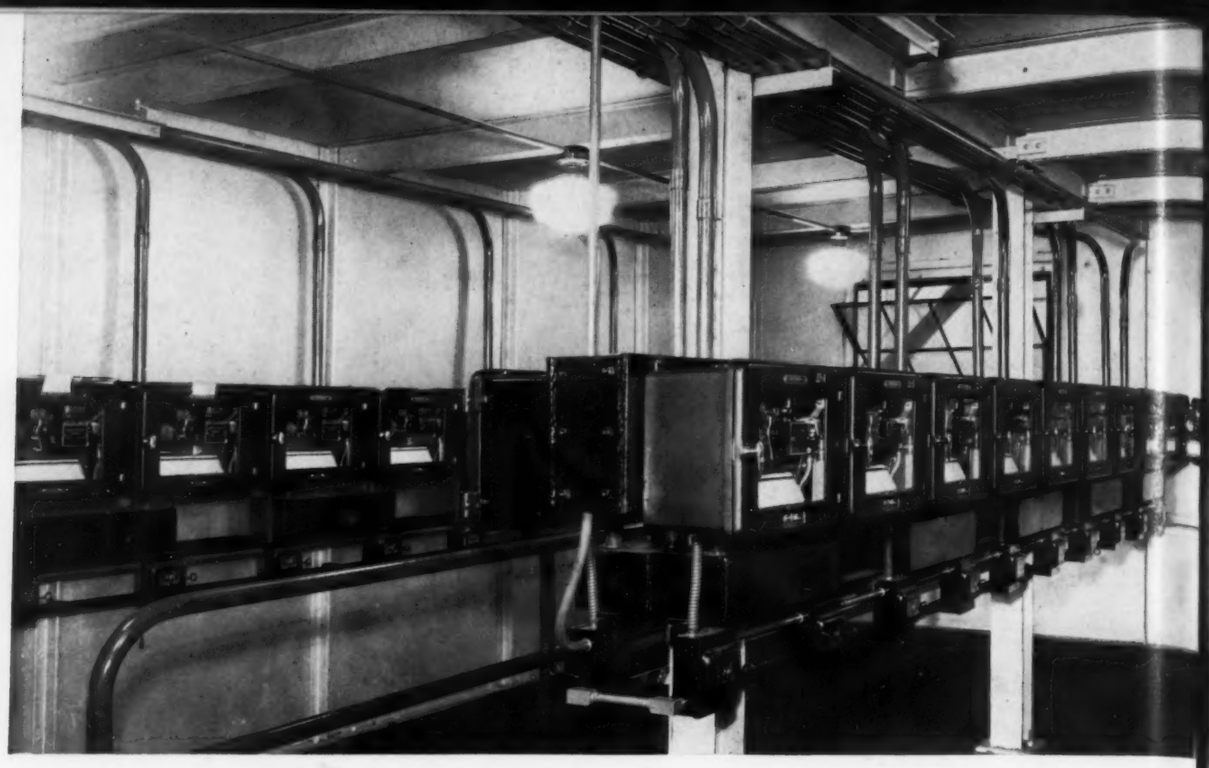
Weirton Steel Co.
WEIRTON, W. VA.

American Steel & Wire Co.
CUYAHOGA WORKS

Intelligent Counsel on all Industrial Lighting Problems

HOLOPHANE COMPANY, Inc.
342 Madison Avenue New York, N. Y.

for EFFICIENCY-PERMANENCE-SAFETY



Two temperatures inside a sheet-annealing box, and one just outside, are shown by each Micromax Pyrometer in this control room at Great Lakes Steel Corporation's E

For *Dependable Controls* Rely o
MICROMAX PYROMETERS

Much of the steel industry's use of Micromax Pyrometers is due to the steel man's liking for solid, substantial machinery. For Micromax is a machine rather than an instrument; its parts are substantial castings, forgings, stampings and shafts having large safety factors. Heat-treatment by the Triple-Control Hump Method is freely used to develop high strength in the parts. Bearings are ample. Assembly is careful; tolerances are close and alignments permanent; accuracy and responsiveness are practically unaffected by wear. This machine operates in the same powerful, sure style as a machine tool. It is available in models that supply temperature indication, record, signals or control in exactly the combination needed for a given application.

L&N PRODUCTS

MEASURING INSTRUMENTS FOR PLANT MEASUREMENT AND CONTROL
Indicators — Recorders
Controllers — Telemeters
Automatic Control

ELECTRIC HEAT-TREATING FURNACES
Triple-Control Hump Hardening
Homo Tempering
Homo Nitriding
Ho-Hump Multipurpose Furnaces

MEASURING INSTRUMENTS FOR RESEARCH, TESTING AND TEACHING
Potentiometers — Bridges
Test Sets — Standards
Galvanometers — Dynamometers
Photometric and Synchronous Equipment

See the L & N Exhibit at The Iron & Steel Show

J-626B (1)

LEEDS & NORTHRUP COMPANY
4942 STENTON AVENUE — PHILADELPHIA, PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS - TELEMETERS - AUTOMATIC CONTROLS - HEAT-TREATING FURNACES

STEEL MEETS
IVE INDUSTRY
UNITED
MESTA

Official Host

TO THE CONVENTION

GEORGE R. FINK

President

GREAT LAKES STEEL CORPORATION

GREAT LAKES STEEL CORPORATION

DIVISION OF NATIONAL STEEL CORPORATION

ECORSE, DETROIT, MICHIGAN

GEORGE R. FINK
PRESIDENT

July 27, 1936

Association of Iron and Steel Engineers
Empire Building
Pittsburgh, Pennsylvania

Gentlemen:

Appreciating the contributions your organization has made to the technical progress of the Iron and Steel Industry, I extend a hearty welcome to you in your 32nd Annual Convention which meets in Detroit, September 22, 23, 24, and 25.

The accomplishments of the Association of Iron and Steel Engineers, since it was founded under the name of the Association of Iron and Steel Electrical Engineers twenty-nine years ago, has been written in the history of the Iron and Steel Industry. Starting with the early labors to improve the first inefficient electrical apparatus for the steel-making industry, the Association has pioneered boldly in the development of the most efficient plant machinery and engineering practice. It has brought about the present high standing of engineering practice and steel-making equipment as applied to the Iron and Steel Industry.

The varied and valuable products and machinery, making up the exposition to be held in Convention Hall in connection with the Convention, will afford further opportunities for education and enlightenment to those interested not only in steel-making but in the ultimate use of steel in many consuming lines.

One of the vitally important features of all past conventions of the Association has been the discussion at the scheduled technical session, of subjects of paramount importance to those engaged in the Industry. These subjects have been presented by men whose interests are devoted to practical problems involved in improving steel and steel-making methods. This year's convention again will offer an opportunity to hear the latest thought on this phase of the industry's problem from able authorities in the field.

Bearing in mind the fine cooperation and the spirit of mutual helpfulness the Association strives always to promote, the Great Lakes Steel Corporation extends a cordial invitation to the Association members and guests to visit the Great Lakes Steel plant.

Very truly yours,

George R. Fink

George R. Fink
President.

GRF/k

H. G. R. BENNETT
President
Association of
Iron and Steel Engineers

J. A. CLAUSS
General
Chairman
of Convention and
Exposition

CONVENTION COMMITTEES

GENERAL CONVENTION COMMITTEE

J. A. CLAUSS, Chairman

C. H. Hunt
J. A. Morton
K. E. Dinius
J. H. Wagner
R. F. Chaffin
L. C. Edgar
W. H. Baltzell
David Thomson
L. R. Rankin
Wilfred Sykes
J. S. Murray

S. N. Roberts
L. H. Mandeville
K. A. Landgrebe
H. D. Esterley
H. E. Siebert
T. B. McElray
A. W. Steed
J. A. Brua
H. R. Zimmerman
H. E. Boedecker
George E. Rose

H. G. Gibson
C. W. Phillips
G. E. Adams
J. S. Kenney
G. S. Warren
A. E. Miller
T. E. Hughes
G. M. Coughlin
J. A. Morgan
G. H. Greene
G. W. Moomaw

J. H. Van Campen
L. A. Terry
C. H. Manion
H. N. Pendleton
Leonard Larsen
F. F. Foss
R. E. Lewis
H. E. Davis
J. Gordon Gage
H. H. Angel
C. J. Smith

Wm. Jackson
E. W. Trexler
E. H. Koenig
L. A. Wynd
H. B. Conover
V. Chartner
J. O'Malia
D. A. Keating
John Lehnert
T. R. Moxley
D. I. Bohn

REGISTRATION COMMITTEE

C. A. THAYER, Chairman
S. GRAND GIRARD, Vice Chairman

J. H. Albrecht
T. S. Towle
J. D. Corfield
C. H. Saiter
M. J. Wolgemuth
G. E. Stimple
H. C. Cheston

E. R. Dunn
J. H. Rashba
G. L. Stout
C. L. Joly
B. C. Hooper
Walter Anderson
J. B. Kelsey

George T. Ladd
J. W. Grant
L. F. Fair
R. M. Baines
H. A. Crowther
T. J. Kauffeld
J. D. Peterson

T. R. Gano
C. B. Cook
G. P. Dempler
E. J. Hull
J. M. Ireland
L. M. Klinedinst
C. Ostrom

H. W. Stoetzel
E. Dowling
L. P. Tyler
F. B. Godard
H. M. Hammond

IRON AND STEEL EXPOSITION COMMITTEE

L. F. COFFIN, Chairman

H. J. Baugh
A. W. Duncan
S. Findlatter
H. W. Neblett
T. J. Flaherty
E. C. McDonald
O. R. Jones
J. S. Murray
L. W. Long

J. W. Jones
A. R. Dibben
J. H. Vohr
L. H. Burnett
S. E. McQuigg
J. D. Dillon
H. F. Raab
C. A. Baumann
W. A. James

R. C. Boak
A. G. Witting
J. C. Allen
A. L. Milton
J. H. McElhinney
K. H. McLaurin
J. D. Scully
H. D. Reilly
W. S. Riggs

R. H. Stevens
G. H. Fish
L. F. McCaffrey
J. M. Darbaker
E. H. Cocain
G. N. Harmon
J. A. Carter
J. S. Pastorius
G. A. Kauffman

J. A. Burg
H. V. Flagg
L. A. Wynd
G. J. Walz
T. J. Ess
F. P. May
J. G. Walsh
C. M. Myers

COMMITTEE ON ATTENDANCE

F. E. LEAHY, Chairman

John L. Young
J. W. Corey
A. A. VanPelt
J. K. Keogh
E. H. Wagenseil
A. J. Jennings
H. H. Wood
J. R. Lewis
E. S. Glauch

H. A. Winne
W. D. Hodson
A. J. Boynton
W. W. Powell
R. M. Gordon
V. A. Menaglia
H. D. Rei
A. E. Krogh
A. S. McCloy

H. D. Robb
H. J. Fisher
W. R. Duda
J. M. Kelly
Malcomb Nesbit
F. R. Dallye
J. S. Smith
H. E. Ewart
J. P. Flippen
E. A. Harper

R. G. Widdows
J. Guy Griffith
W. E. Blythe
J. Duff Reed
E. F. Carey
D. J. Richards
G. R. Horne
H. J. Hall
J. R. Seaman

V. J. Nolan
G. E. Stoltz
F. H. Barnard
P. M. Offill
W. J. Ramsey
M. J. Bradley
H. A. Fennerty
R. M. Currie
J. Green

EXHIBITORS INFORMAL DANCE COMMITTEE

L. F. MCCAFFERY, Chairman
J. H. GRAFT, Vice Chairman

J. J. Bangert
B. J. Ballard
J. K. Mahaffey
C. E. Bedell
A. M. Ramsey
R. E. Brown

R. W. Thompson
O. Schauer
R. W. Leech
A. E. Balke
W. H. Williams
W. H. Boyce

N. M. Kiener
F. J. Burd
M. Reswick
M. J. Van Leeuwen
W. A. Lintern
H. E. Slack

L. T. Barry
Frank Smith
T. D. MacLafferty
W. H. Oldacre
H. S. Richardson
F. W. Vogt

A. C. Dyer
Jos. Kinney, Jr.
R. J. Geisler
A. J. Dreyer
F. C. Lamar
E. F. Weiss
H. J. Saladin

FORMAL RECEPTION COMMITTEE

H. G. R. BENNETT, Chairman
F. A. WILEY, Vice Chairman

L. F. Coffin
C. C. Wales
F. E. Flynn
W. A. Perry
C. C. Pecu
O. R. Jones

J. D. Donovan
F. D. Egan
F. W. Cramer
J. C. Reed
W. H. Burr
J. W. Bates

G. N. Hughes
H. G. Hague
A. C. Cummins
D. M. Petty
C. L. McGranahan
E. Freidlander

J. A. Clauss
M. J. Conway
W. S. Hall
A. J. Standing
Jas. Farrington

G. R. Carroll
J. L. Miller
R. G. Adair
F. E. Leahy
F. O. Schmure

H. G. R. BENNETT
President
Association of
Iron and Steel Engineers

J. A. CLAUSS
General
Chairman
of Convention and
Exposition

CONVENTION COMMITTEES

GENERAL CONVENTION COMMITTEE

J. A. CLAUSS, Chairman

C. H. Hunt
J. A. Morton
K. E. Dinius
J. H. Wagner
R. F. Chaffin
L. C. Edgar
W. H. Baltzell
David Thomson
L. R. Rankin
Wilfred Sykes
J. S. Murray

S. N. Roberts
L. H. Mandeville
K. A. Landgrebe
H. D. Esterley
H. E. Siebert
T. B. McElray
A. W. Steed
J. A. Brua
H. R. Zimmerman
H. E. Boedecker
George E. Rose

H. G. Gibson
C. W. Phillips
G. E. Adams
J. S. Kenney
G. S. Warren
A. E. Miller
T. E. Hughes
G. M. Coughlin
J. A. Morgan
G. H. Greene
G. W. Moomaw

J. H. Van Campen
L. A. Terry
C. H. Manion
H. N. Pendleton
Leonard Larsen
F. F. Foss
R. E. Lewis
H. E. Davis
J. Gordon Gage
H. H. Angel
C. J. Smith

Wm. Jackson
E. W. Trexler
E. H. Koenig
L. A. Wynd
H. B. Conover
V. Chartner
J. O'Malia
D. A. Keating
John Lehnert
T. R. Moxley
D. I. Bohn

REGISTRATION COMMITTEE

C. A. THAYER, Chairman
S. GRAND GIRARD, Vice Chairman

J. H. Albrecht
T. S. Towle
J. D. Corfield
C. H. Saiter
M. J. Wolgemuth
G. E. Stimple
H. C. Cheston

E. R. Dunn
J. H. Rashba
G. L. Stout
C. L. Joly
B. C. Hooper
Walter Anderson
J. B. Kelsey

George T. Ladd
J. W. Grant
L. F. Fair
R. M. Baines
H. A. Crowther
T. J. Kauffeld
J. D. Peterson

T. R. Gano
C. B. Cook
G. P. Dempler
E. J. Hull
J. M. Ireland
L. M. Klinedinst
C. Ostrom

H. W. Stoetzel
E. Dowling
L. P. Tyler
F. B. Godard
H. M. Hammond

IRON AND STEEL EXPOSITION COMMITTEE

L. F. COFFIN, Chairman

H. J. Baugh
A. W. Duncan
S. Findlatter
H. W. Neblett
T. J. Flaherty
E. C. McDonald
O. R. Jones
J. S. Murray
L. W. Long

J. W. Jones
A. R. Dibben
J. H. Vohr
L. H. Burnett
S. E. McQuigg
J. D. Dillon
H. F. Raab
C. A. Baumann
W. A. James

R. C. Boak
A. G. Witting
J. C. Allen
A. L. Milton
J. H. McElhinney
K. H. McLaurin
J. D. Scully
H. D. Reilly
W. S. Riggs

R. H. Stevens
G. H. Fish
L. F. McCaffrey
J. M. Darbaker
E. H. Cocain
G. N. Harmon
J. A. Carter
J. S. Pastorius
G. A. Kauffman

J. A. Burg
H. V. Flagg
L. A. Wynd
G. J. Walz
T. J. Ess
F. P. May
J. G. Walsh
C. M. Myers

COMMITTEE ON ATTENDANCE

F. E. LEAHY, Chairman

John L. Young
J. W. Corey
A. A. VanPelt
J. K. Keogh
E. H. Wagenseil
A. J. Jennings
H. H. Wood
J. R. Lewis
E. S. Glauch

H. A. Winne
W. D. Hodson
A. J. Boynton
W. W. Powell
R. M. Gordon
V. A. Menaglia
H. D. Rei
A. E. Krogh
A. S. McCloy

H. D. Robb
H. J. Fisher
W. R. Duda
J. M. Kelly
Malcomb Nesbit
F. R. Dallye
J. S. Smith
H. E. Ewart
J. P. Flippen
E. A. Harper

R. G. Widdows
J. Guy Griffith
W. E. Blythe
J. Duff Reed
E. F. Carey
D. J. Richards
G. R. Horne
H. J. Hall
J. R. Seaman

V. J. Nolan
G. E. Stoltz
F. H. Barnard
P. M. Offill
W. J. Ramsey
M. J. Bradley
H. A. Fennerty
R. M. Currie
J. Green

EXHIBITORS INFORMAL DANCE COMMITTEE

L. F. MCCAFFERY, Chairman
J. H. GRAFT, Vice Chairman

J. J. Bangert
B. J. Ballard
J. K. Mahaffey
C. E. Bedell
A. M. Ramsey
R. E. Brown

R. W. Thompson
O. Schauer
R. W. Leech
A. E. Balke
W. H. Williams
W. H. Boyce

N. M. Kiener
F. J. Burd
M. Reswick
M. J. Van Leeuwen
W. A. Lintern
H. E. Slack

L. T. Barry
Frank Smith
T. D. MacLafferty
W. H. Oldacre
H. S. Richardson
F. W. Vogt

A. C. Dyer
Jos. Kinney, Jr.
R. J. Geisler
A. J. Dreyer
F. C. Lamar
E. F. Weiss
H. J. Saladin

FORMAL RECEPTION COMMITTEE

H. G. R. BENNETT, Chairman
F. A. WILEY, Vice Chairman

L. F. Coffin
C. C. Wales
F. E. Flynn
W. A. Perry
C. C. Pecu
O. R. Jones

J. D. Donovan
F. D. Egan
F. W. Cramer
J. C. Reed
W. H. Burr
J. W. Bates

G. N. Hughes
H. G. Hague
A. C. Cummins
D. M. Petty
C. L. McGranahan
E. Freidlander

J. A. Clauss
M. J. Conway
W. S. Hall
A. J. Standing
Jas. Farrington

G. R. Carroll
J. L. Miller
R. G. Adair
F. E. Leahy
F. O. Schnure

Official Program

32ND ANNUAL CONVENTION AND IRON AND STEEL EXPOSITION

DETROIT, MICHIGAN

SEPTEMBER 22, 23, 24, 25, 1936

Technical Sessions
Hotel Statler

Iron and Steel Exposition
Convention Hall, Cass Avenue

TUESDAY, SEPTEMBER 22, 1936

Ball Room Floor, Hotel Statler

9:00 A. M. Assembly Hall.

Registration

CHAIRMAN
C. A. THAYER, Chief Engineer, Republic Steel Corporation, Cleveland, Ohio.

VICE CHAIRMAN
S. GRAND-GIRARD, Electrical Engineer, Sharon Steel Corporation, Sharon, Pa.

Large Banquet Room

CHAIRMAN
H. G. R. BENNETT, Assistant General Superintendent Carnegie-Illinois Steel Corp. Duquesne, Pa.

VICE CHAIRMAN
J. L. MILLER, Assistant Chief Engineer, Carnegie-Illinois Steel Corp. Youngstown, Ohio.

9:15 A.M.

Annual Meeting and Business Session of Association of Iron and Steel Engineers.

9:30 A.M.

"DEVELOPMENTS IN THE IRON AND STEEL INDUSTRY DURING 1935-1936" by W. H. Burr, Electrical and Mechanical Superintendent, Lukens Steel Company, Coatesville, Pa.

10:00 A.M.

"STEEL SHEETS FOR TODAY'S MOTOR CAR—MECHANICAL AND ELECTRICAL PROBLEMS OF FABRICATION" by Thomas P. Archer, Vice President in Charge of Operations, Fisher Body Company, Detroit, Michigan, and R. A. Geuder, Electrical Engineer, Reliance Electric and Engineering Company, Cleveland, Ohio.

10:45 A.M.

"DEVELOPMENTS IN THE FLAT ROLLED STEEL INDUSTRY DURING 1935-1936" by Stephen Badlam, Consulting Engineer, Pittsburgh, Penna.

11:15 A.M.

CHAIRMAN
FRANK PURNELL, President Youngstown Sheet & Tube Co. Youngstown, Ohio

VICE CHAIRMAN
F. E. FLYNN, Gen. Supt. Republic Steel Corporation Warren, Ohio

"SEASONAL AND PRESENT ECONOMIC TREND OF THE AUTOMOBILE BUSINESS" by C. E. Wilson, Vice President, General Motors Corporation, Detroit, Mich.

Main Ball Room

1:15 P.M.

CHAIRMAN
HENRY A. ROEMER, President, Pittsburgh Steel Company, Pittsburgh, Pa.

VICE CHAIRMAN
F. D. EGAN, Elec. Supt. Bethlehem Steel Co. Lackawanna, N. Y.

"THE STEEL AND THE AUTOMOTIVE INDUSTRIES" by B. F. Fairless, President, Carnegie-Illinois Steel Corporation, Pittsburgh, Pa.

Main Ball Room

2:15 P.M.

CHAIRMAN
C. A. KRAL, Assistant General Manager Wheeling Steel Corporation, Steubenville, Ohio.

VICE CHAIRMAN
S. M. JENKS, Chief Engineer, Carnegie-Illinois Steel Corporation Pittsburgh, Pa.

"MATERIAL HANDLING FACILITIES FOR HOT AND COLD STRIP MILLS" by Fred M. Gillies, Assistant General Superintendent, Inland Steel Company, Indiana Harbor, Indiana.

2:45 P.M.

"ELECTRICAL APPLICATIONS IN CONTINUOUS HOT STRIP MILLS" by L. A. Umansky, Industrial Engineering Department, General Electric Company, Schenectady, N. Y.

3:30 P.M.

"OPERATION OF RUNOUT TABLES, COILER DRIVES AND ADJUSTABLE SPEED FREQUENCY SETS INTREPRETED THROUGH THE OSCILLOGRAPH" by F. E. Harrell, Assistant Chief Engineer and W. R. Hough, Experimental Engineer, Reliance Electric and Engineering Company, Cleveland, Ohio.

7:30 P.M.

VISIT TO IRON AND STEEL EXPOSITION, CONVENTION HALL, CASS AVENUE, by National Officers, National Engineering Committees, Members and Guests of the Association of Iron and Steel Engineers.

9:30 P.M.

CHAIRMAN
LEO MCCAFFERTY, Mill Superintendent, Ford Motor Company Detroit, Mich.

VICE CHAIRMAN
J. H. GRAFT, Electrical Superintendent, Republic Steel Corporation, Youngstown, Ohio.

EXHIBITOR'S INFORMAL DANCE, Ball Room, Hotel Statler.

WEDNESDAY, SEPTEMBER 23, 1936

Large Banquet Room, Hotel Statler

CHAIRMAN
F. E. FLYNN, General Superintendent, Republic Steel Corporation Warren, Ohio.

VICE CHAIRMAN
H. J. BAUGH, Asst. Gen. Supt. Carnegie-Illinois Steel Corp. Youngstown, Ohio

9:15 A.M.

"BRIGHT ANNEALING AND NORMALIZING AUTO BODY STOCK STEEL IN ELECTRIC FURNACES" by F. T. Hague, Manager DC Engineering Department and P. H. Brace, Manager Metallurgical Department, Research Division, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

10:00 A.M.

"SHEET AND STRIP STEEL FOR DEEP DRAWING PURPOSES" by Joseph Winlock, Chief Metallurgist, Edward G. Budd Manufacturing Company, Philadelphia, Pa.

11:00 A.M.

"Heat Treating Alloy Bar Stock in Electric Furnaces" by Dr. Marcus A. Grossmann, Director of Research, Carnegie-Illinois Steel Corporation, Chicago, Ill.

11:45 A.M.

"The Development of the Great Lakes Steel Corporation" by George R. Fink, President, Great Lakes Steel Corporation, Ecorse, Michigan.

12:45 P.M.

Inspection Trip to Great Lakes Steel Corporation, Ecorse, Mich. Special buses which the A. I. & S. E. will provide and which the guests must use, will leave the Hotel Statler at 12:45 P.M. (E.S.T.). Price $2.00 per person. Tickets available at A. I. & S. E. Registration Desk or Iron and Steel Exposition office, Convention Hall, Cass Avenue.

THURSDAY, SEPTEMBER 24, 1936

Lubrication Engineering Division

Small Banquet Room, Ball Room Floor, Hotel Statler

Chairman
C. C. Pecu,
Lubrication Engineer,
Bethlehem Steel Company,
Lackawanna, New York.

Vice Chairman
F. J. Thomas,
Chief Lubrication Engineer,
Republic Steel Corporation,
Cleveland, Ohio.

9:30 A.M.

"Centralized Lubrication and Roll Cooling Systems" by T. J. Kauffeld, Special Representative, DeLaval Separator Company, Pittsburgh, Pa.

10:15 A.M.

"Lubrication of Steel Mill Equipment" by C. J. Klein, Chief Engineer, Weirton Steel Company, Weirton, West Va.

11:00 A.M.

"Some Ideas in Lubrication" by Arthur W. Burwell, Technical Director, Alox Corporation, Niagara Falls, New York.

Mechanical, Electrical, Lubrication and Welding Engineering Divisions

Ball Room Floor, Hotel Statler

Chairman
C. C. Wales, Chief Engineer,
Otis Steel Company,
Cleveland, Ohio.

Vice Chairman
J. W. Bates, Electrical Engineer,
Power Division,
Carnegie-Illinois Steel Corporation
Pittsburgh, Pa.

1:15 P.M.

"Developments in Rolling Mills at the Ford Motor Company" by M. Stone, Engineer, United Engineering & Foundry Company, Pittsburgh, Pa.

Combustion Engineering Division

Large Banquet Hall, Ball Room Floor, Hotel Statler

Chairman
J. L. Mauthe, Assistant General
Superintendent,
Youngstown Sheet & Tube Co.
Youngstown, Ohio.

Vice Chairman
Martin J. Conway, Fuel
Engineer,
Lukens Steel Company,
Coatesville, Pa.

9:15 A.M.

"Automatic Control in Open Hearth Furnaces" by A. F. Spitzglass, Vice President, Republic Flow Meters Company, Chicago, Ill.

10:00 A.M.

"Soaking Pits" by P. M. Offill, Vice President, Amsler Morton Company, Pittsburgh, Pa.

10:30 A.M.

"The Trend in Refractories Application in the Steel Plant" by A. V. Leun, Refractory Engineer, Bethlehem Steel Company, Bethlehem, Pa.

11:15 A.M.

"Recuperators for Continuous Slab Heating Furnaces" by W. H. Fitch, Manager, Recuperator Department, Carborundum Company, Perth Amboy, N. J.

2:15 P.M.

"Gas Distribution at the Ford Motor Company" by F. J. Harlow, Manager, Industrial Division, Philgas Department, Phillips Petroleum Company, Detroit, Mich.

3:00 P.M.

"Study of Blast Furnace Charging" by Gordon Fox, Vice President, Freyn Engineering Company, Chicago, Ill.

4:00 P.M.

"Inhibitors and Their Probable Mechanism" by G. Walter Esau, Metallurgical Engineer, E. F. Houghton & Company, Philadelphia, Pa.

Welding Engineering Division

Small Banquet Hall, Ball Room Floor, Hotel Statler

Chairman
E. C. Marshall,
Electrical Engineer,
Youngstown Sheet & Tube Co.
Youngstown, Ohio.

Vice Chairman
Wray Dudley,
Electrical Superintendent,
National Tube Company,
McKeesport, Pa.

2:00 P.M.

"Development in Welding During 1935-1936" by Grover A. Hughes, Electrical Engineer, Truscon Steel Company, Youngstown, Ohio.

2:30 P.M.

"Resistance Welding in Steel Plants" by Walter Anderson, Vice President and Malcomb Clark, General Manager, Taylor Winfield Corporation, Warren, Ohio.

3:00 P.M.

"How Arc Welding Aids in the Use of Standard Steel Mill Products in the Electrical Industry" by O. A. Tilton, Industrial Engineering Department, General Electric Company, Schenectady, N. Y.

3:30 P.M.

"Commercial Welding as Applied to Steel Mills" by H. A. Woofter, Chief Engineer, The Federal Machine & Welder Company, Warren, Ohio.

THURSDAY EVENING

Ball Room, Hotel Statler

Chairman
H. G. R. Bennett, Assistant
General Superintendent,
Carnegie-Illinois Steel Corp.
Duquesne, Pa.

Vice Chairman
F. A. Wiley, Electrical Superintendent,
International Harvester Company
Chicago, Ill.

9:30 P.M.

Formal Reception

FRIDAY, SEPTEMBER 25, 1936

9:15 A.M.

Inspection Trip to steel plant, rolling mills and assembly line, Ford Motor Company, Detroit, Michigan. Special buses which the A. I. & S. E. will provide and the guests must use will leave the Hotel Statler at 9:15 A.M. Price $2.00 per person. Tickets available at A. I. & S. E. Registration Desk, Hotel Statler or Iron and Steel Exposition Office, Convention Hall, Cass Avenue.

PRESIDING OFFICERS AN UT

J. L. MILLER
Assistant Chief Engineer
Carnegie-Illinois Steel Corporation
Youngstown, Ohio

J. W. BATES
Electrical Engineer, Power Division
Carnegie-Illinois Steel Corporation
Pittsburgh, Pa.

F. E. FLYNN
General Superintendent
Republic Steel Corporation
Warren, Ohio

C. A. KRAL
Assistant General Manager
Wheeling Steel Corporation
Steubenville, Ohio

C. C. WALES
Chief Engineer
Otis Steel Company
Cleveland, Ohio

C. C. PECU
Lubrication Engineer
Bethlehem Steel Company
Lackawanna, N. Y.

AN AUTHORS AT CONVENTION

M. STONE
Engineer
ted Engineering & Foundry Company
Pittsburgh, Pa.

H. A. WOOFTER
Chief Engineer
Federal Machine & Welder Company
Warren, Ohio

LEO McCAFFREY
Ford Motor Company
Detroit, Mich.

G. WALTER ESAU
Metallurgical Engineer
E. F. Houghton & Company
Philadelphia, Pa.

ARTHUR W. BURWELL
Technical Director
Alox Corporation
Niagara Falls, N. Y.

R. A. GEUDER
Electrical Engineer
Reliance Electric & Engineering Company
Cleveland, Ohio

PRESIDING OFFICERS AT CONVENTION

C. A. THAYER, Chief Engineer
Republic Steel Corporation
Cleveland, Ohio

WRAY DUDLEY
Electrical Superintendent
National Tube Company
McKeesport, Pa.

GROVER A. HUGHES
Electrical Engineer
Truscon Steel Company
Youngstown, Ohio

JOHN H. GRAFT
Electrical Superintendent
Republic Steel Corporation
Youngstown, Ohio

STANLEY GRAND-GIRARD
Electrical and Mechanical Superintendent
Sharon Steel Corporation
Sharon, Penna.

J. L. MAUTHE
Assistant General Superintendent
Youngstown Sheet & Tube Company
Youngstown, Ohio

Executives

PARTICIPATING IN CONVENTION

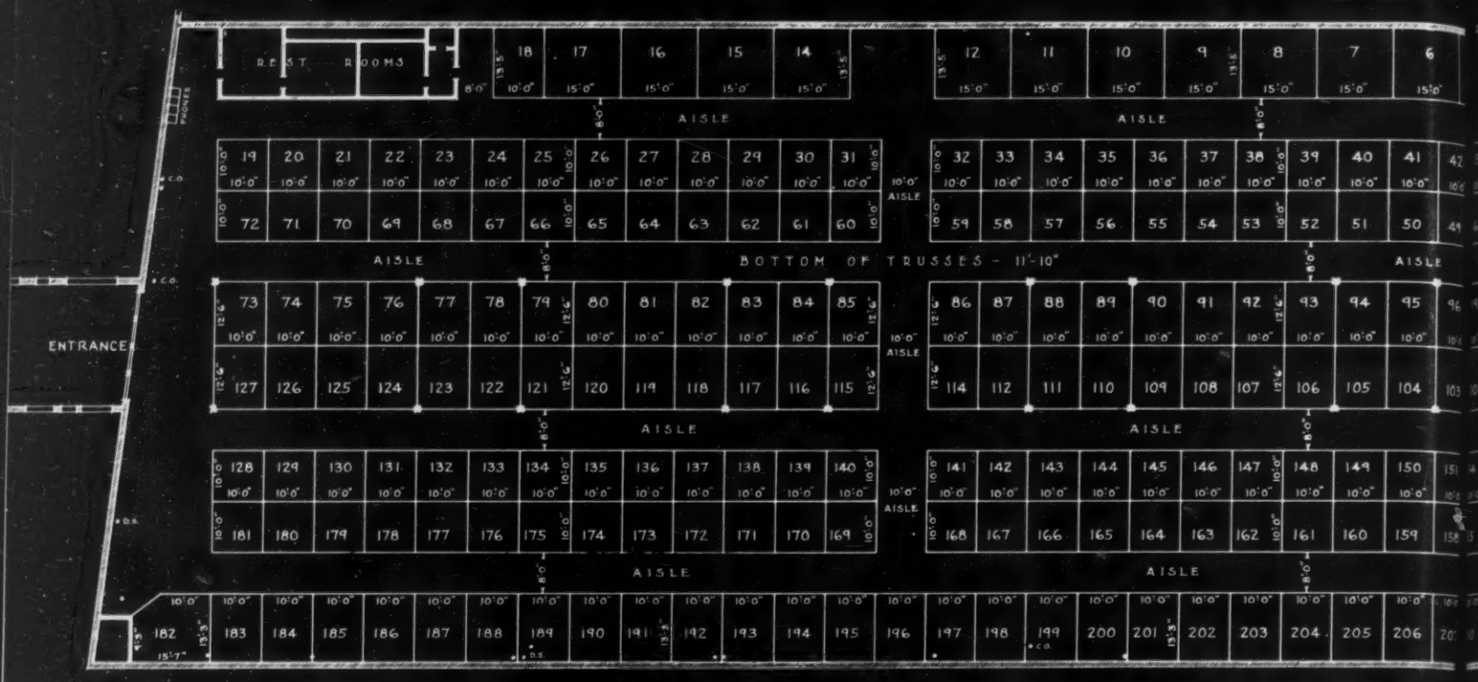
B. F. FAIRLESS
President
Carnegie-Illinois Steel Corp.
Pittsburgh, Pa.

HENRY A. ROEMER
President
Pittsburgh Steel Company
Pittsburgh, Pa.

(Right)
FRANK PURNELL
President
Youngstown Sheet & Tube Co.
Youngstown, Ohio

THOMAS P. ARCHER
Vice President
Fisher Body Company
Detroit, Mich.

(Right)
C. E. WILSON
Vice President
General Motors Company
Detroit, Mich.



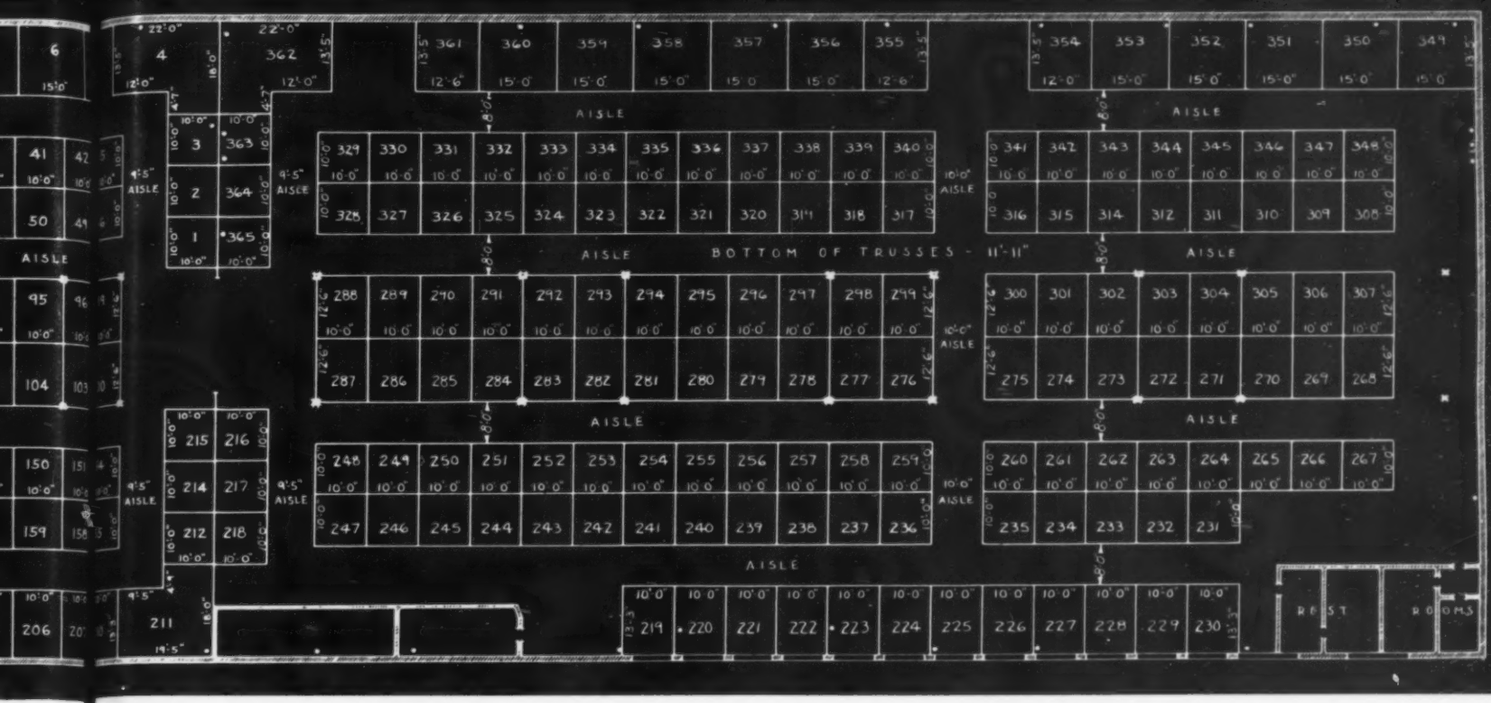
Floor Plan for th on an

. . . Be Sure to Visit the

Where approximately 150 manufacturers of steel and steel making equipment will display their products at the nineteenth Annual Iron and Steel Exposition to be held in Convention Hall, September 22 to 25, 1936. This represents an increase of 100% over the total space used in the 1935 Exposition and an increase of 75 exhibitors.

From a very modest beginning in 1919 when the first exposition was held, this show has grown to the point where this year will see 50,000 square feet of floor space being utilized.

Advance information received from the exhibitors in regard to displays promises an education not only for those interested in the steel industry, but also for the industrial men of the Detroit area. In that the technical program of the convention is being assembled



n for th on and Steel Exposition

he Iron and Steel Exposition

around the wide use of steel in the automotive industry, many of the exhibitors are planning to arrange their exhibits in such a way as to prove of interest to all the engineering officials of the automotive and allied industries in the district.

Many of the exhibits will be in operation which will be of considerable interest to the visitors. In that it would be impossible for some of the large manufacturers of steel mill equipment to exhibit machinery of actual size, the use of miniature models in showing actual operations is gaining much favor and will be used by quite a few companies.

The exposition will open on September 22 at 1:00 P.M. and everyday thereafter will be open from 10:00 10:00 A.M. to 10:00 P.M. Tickets will be available at the Cass Avenue entrance of Convention Hall, as well as at the Hotel Statler.

IRON AND STEEL EXPOSITION

LIST OF EXHIBITORS

FIRM	BOOTHS
A	
Ajax Flexible Coupling Company	4
Allen-Bradley Company	248–249
The Alliance Machine Company	5
The Louis Allis Company	156
Allis-Chalmers Manufacturing Company	206–207–208
Aluminum Company of America	171–172–173
American Air Filter Company Inc.	153
American Car and Foundry Company	157–158
The Amsler-Morton Company	36
Anaconda Wire & Cable Company	177
Appleton Electric Company	52
Askania Regulator Company	121
The Atlas Car & Manufacturing Company	28–29
The Atlas Mineral Products Company of Pennsylvania	67
Automatic Transportation Company	148–149–150
Automatic Temperature Control Company, Inc.	98
B	
Bailey Meter Company	71
The Baker-Raulang Company	80–120
The Bantam Ball Bearing Company	99–100
Barrett-Cravens Company	360
The Bartlett Hayward Company	188
Becker Brothers Carbon Company	53
Benjamin Electric Manufacturing Company	204–205
James G. Biddle Company	194
H. A. Brassert & Company	141–168
The Bristol Company	74–75
The Brown Instrument Company	77–78
Bull Dog Electric Products Company	129–130
Bussmann Manufacturing Company	212
C	
The Carborundum Company	327–328
The Chicago Rawhide Manufacturing Company	96
The Clark Controller Company	32–33–58–59
The Cleveland Crane & Engineering Company	102
Colt's Patent Fire Arms Manufacturing Company	66
Continental Machine Specialties Inc.	42
Continental Roll & Steel Foundry Company	82
Crocker-Wheeler Electric Manufacturing Company	64–65
Crouse-Hinds Company	60–61
The Cuno Engineering Corporation	76
Cutler-Hammer, Inc.	68–73–127

FIRM	BOOTHS
D	
The DeLaval Separator Company	92–93
Delta-Star Electric Company	103
The Detroit Edison Company	62
Joseph Dixon Crucible Company	136
Driver-Harris Company	46–47
E	
Thomas A. Edison, Inc.	118
The Electric Controller & Manufacturing Company	7–8–9
Electric Service Supplies Company	131
The Electric Storage Battery Company	133
Elliott Company	134
The Elwell-Parker Electric Company	19–72
F	
Farrel-Birmingham Company	44
The Farval Corporation	201–202–203
The Foxboro Company	40–41
G	
Gatke Corporation	30–31
General Electric Company	14–15–16–17–18
General Electric Vapor Lamp Company	14–15–16–17–18
General Electric Company (Bridgeport, Conn.)	163
General Electric Supply Corporation	192
Graybar Electric Company, Inc.	152
Great Lakes Steel Corporation	83–84–85–115–116–117
Great Western Fuse Company	169
H	
Hagan Corporation	195–196–197
Harnischfeger Corporation	94–95
The Hays Corporation	54
Hobart Brothers	287–288
Hobart Arc Welder Sales & Service	287–288
The Hodson Corporation	1–2–3
Holophane Company, Inc.	185
Homestead Valve Manufacturing Company	70
E. F. Houghton & Company	214–215
Hyatt Roller Bearing Company	199–200

Firm	Booths
I	
Ideal Commutator Dresser Company	176
Independent Air Filter Company	137
The Iron Age	104–105
I-T-E Circuit Breaker Company	56–57
International Graphite & Electrode Corporation	160
J	
Jefferson Electric Company	69
Johns-Manville	24–25
K	
Kane & Roach, Inc.	161
The C. M. Kemp Manufacturing Company	45
Keystone Lubricating Company	174
L	
Le Carbone Company, Inc.	91
Leeds & Northrup Company	22–23
The Lintern Corporation	138
M	
Mackintosh-Hemphill Company	79
Mathews Conveyor Company	6
Mercury Manufacturing Company	361–365
Mesta Machine Company	186–187
Metals and Alloys	216
Michigan Steel Casting Company	154–155
The Miller Company	106
The Morgan Engineering Company	139–140
Morgan Construction Company	166–167
Morganite Brush Company, Inc.	175
N	
National Carbon Company, Inc.	128–181
National Electric Coil Company	189
National-Erie Corporation	135
New York & New Jersey Lubricant Company	88
Norma-Hoffmann Bearings Corporation	63
Northern Engineering Works	143
O	
Open Hearth Combustion Company	141–168
Otis Elevator Company	124
P	
Penola, Inc.	147
Philadelphia Gear Works	64–65
Poole Foundry & Machine Company	165
The Post-Glover Electric Company	178
Pure Carbon Company, Inc.	132
The Pure Oil Comapny	162
The Pyle-National Company	89–90
R	
Railway and Industrial Engineering Company	34–35
The Ready-Power Company	142
The Reliance Electric & Engineering Company	10–11–12
Republic Flow Meters Company	145–146
Rockbestos Products Corporation	43
Rollway Bearing Company, Inc.	191
Joseph T. Ryerson & Son, Inc.	193
S	
SKF Industries, Inc.	209–210
Socony-Vacuum Oil Company, Inc.	190
Speer Carbon Company	160
Square D Company	86–87
Standard Conveyor Company	37
Standard Oil Company of Indiana	50–51
Standard Oil Company of New Jersey	147
Steel	48–49
D. A. Stuart & Company	198
T	
C. J. Tagliabue Manufacturing Company	38–39
The Texas Company	97
The Thompson Electric Company	170
The Timken Roller Bearing Company	182–183–184
The Tool Steel Gear and Pinion Company	122–123
Trabon Engineering Corporation	81–119
The Trumbull Electric Manufacturing Company	20–21
U	
United American Bosch Corporation	26–27
United Engineering and Foundry Company	125–126
The United States Graphite Company	164
R. E. Uptegraff Manufacturing Company	55
W	
Wagner Electric Corporation	179–180
Westinghouse Electric & Manufacturing Company	108–109–110–111–112–114
Weston Electrical Instrument Corporation	176
Wheeler Reflector Company	101
Edwin L. Wiegand Company	98
Daniel Woodhead Company	151
Y	
The Yale & Towne Manufacturing Company	211
York Oil Burner Company, Inc.	144

CONVENTION INSPECTION TRIPS

Great Lakes Steel Corp.

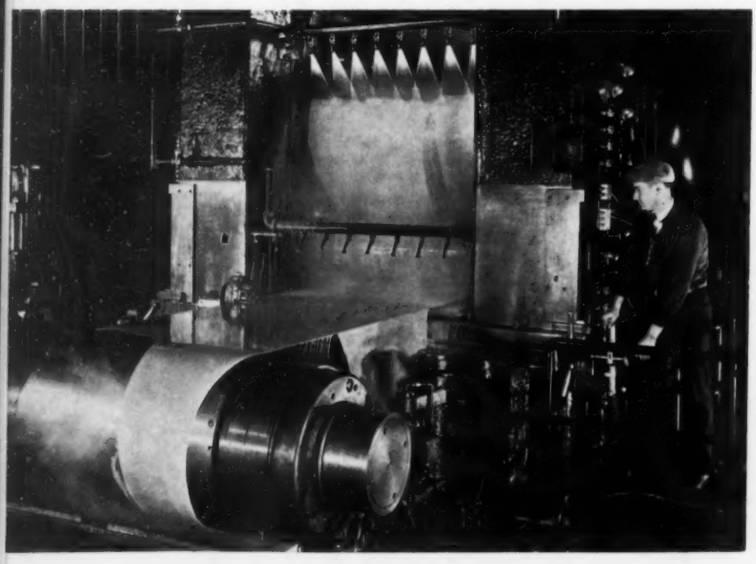
WEDNESDAY AFTERNOON
SEPTEMBER 23rd
12:45 P. M.

The trip of inspection to the Great Lakes Steel Corporation will leave the Statler Hotel on Wednesday afternoon at 12:45 P.M. Special buses have been secured to transport the members and guests to and from the plant. The officials of the Great Lakes Steel Corporation have requested that all those who make the trip, must use the special transportation facilities, otherwise they will not be permitted to enter the plant.

Tickets will be on sale at the Registration Desk in the Hotel Statler beginning Tuesday morning. The price will be $2.00 per person. These may also be secured at the Floor Manager's office at the Iron and Steel Exposition in Convention Hall.

Aerial View of Great Lakes Steel Corporation

View of Cold Mill, Ford Motor Company

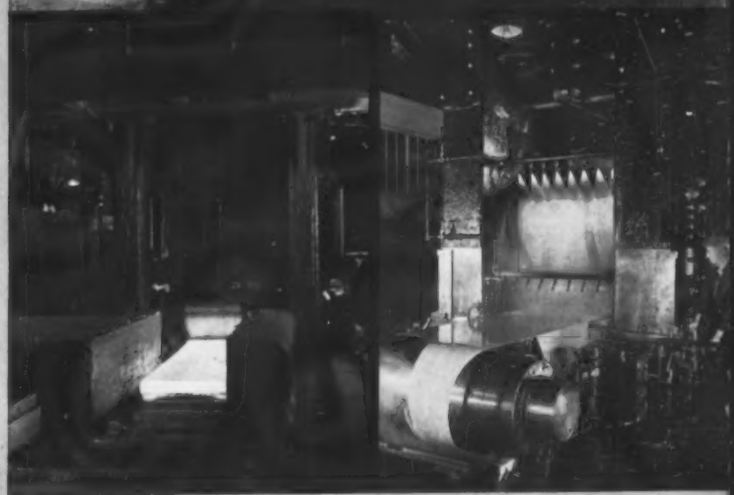


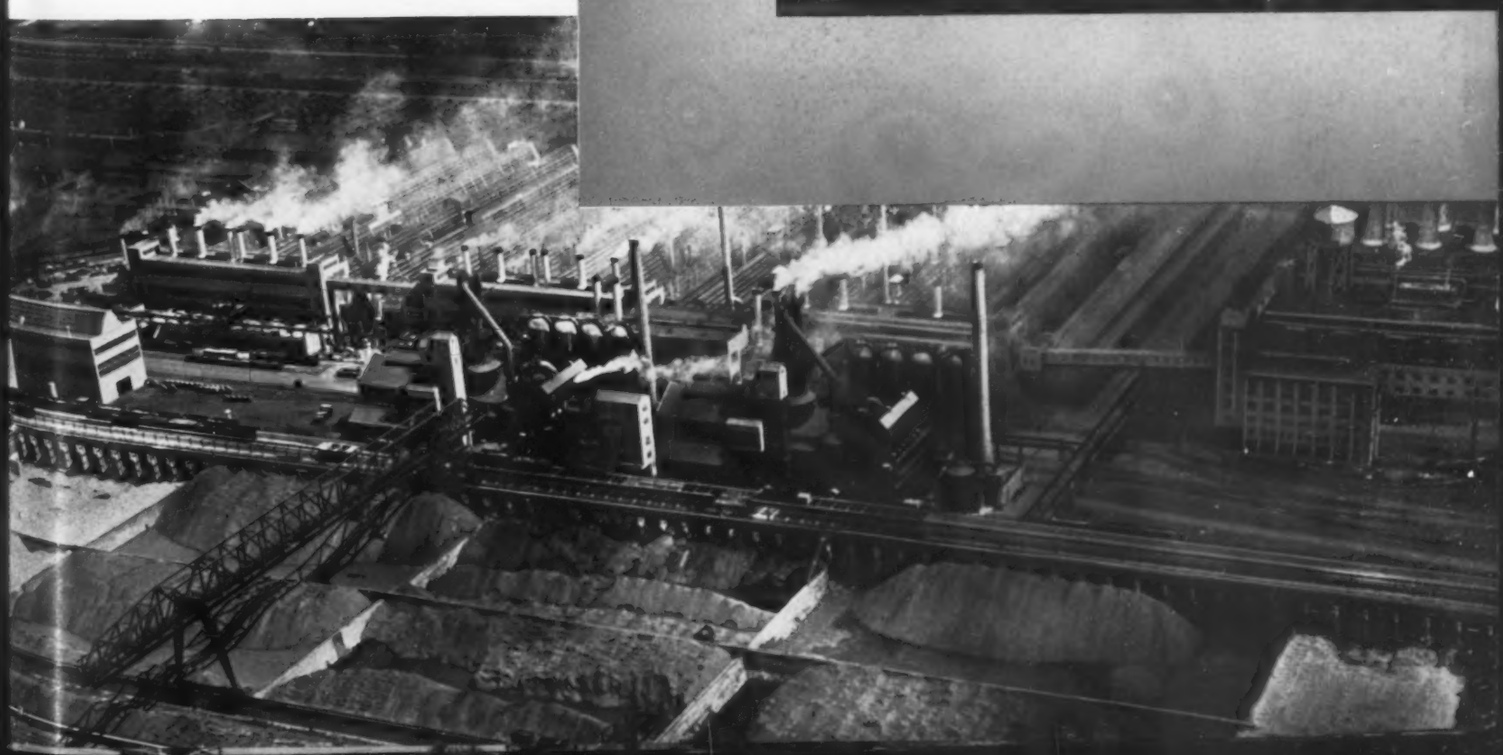
Ford Motor Company

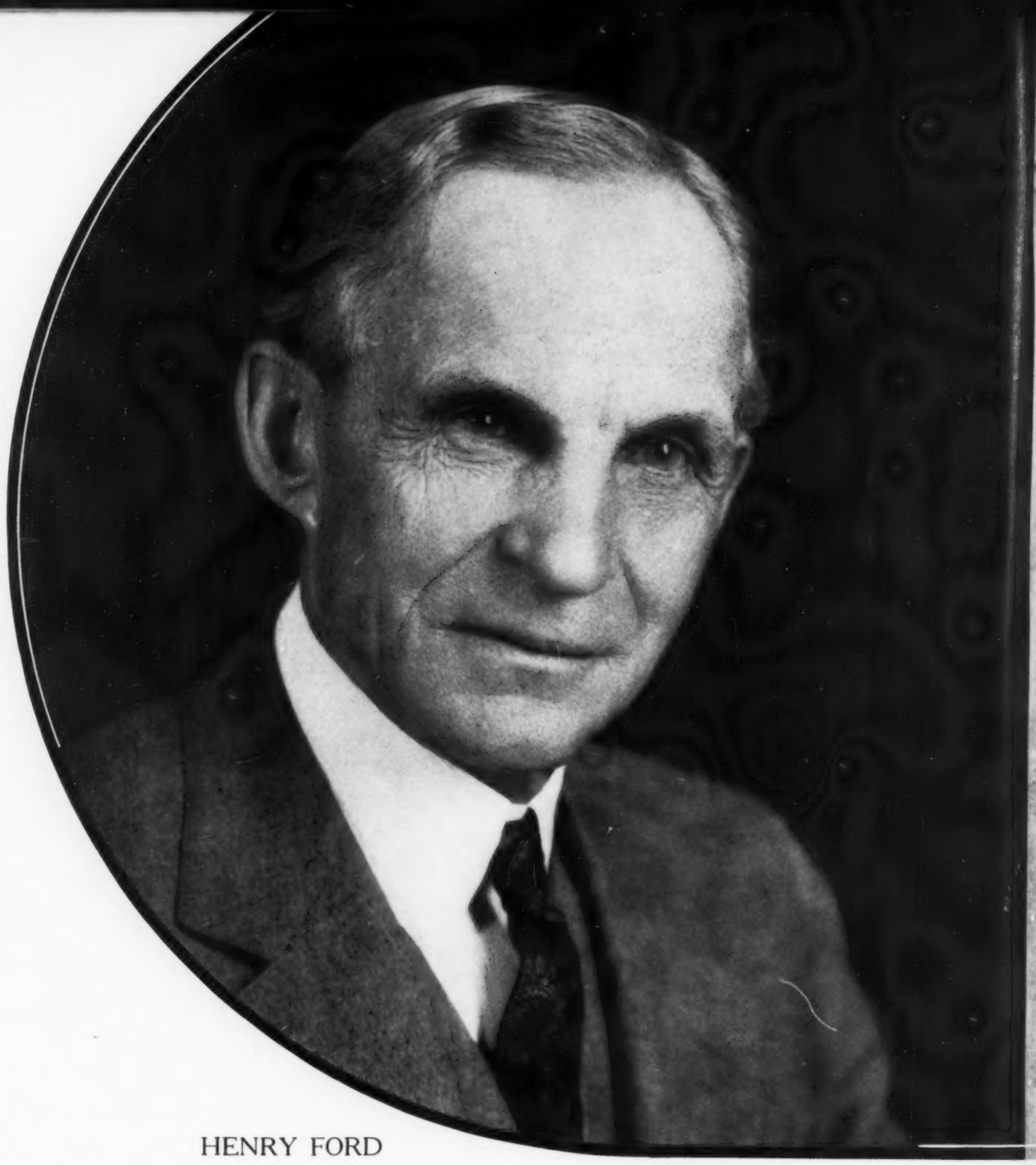
FRIDAY MORNING
SEPTEMBER 25th
9:15 A. M.

The same general plan used in connection with the trip to the Great Lakes plant will be carried out in connection with the trip on Friday morning 9:15 A.M. to the steel mills of the Ford Motor Company. Everyone must use the special buses in order to be permitted admittance to the plant. Tickets will be available at the same sources and the cost will be $2.00 per person.

STEEL PLANT OF THE FORD MOTOR COMPANY







HENRY FORD

Aerial view of Ford Rouge Plant wi
administration building and rotunda
foreground. Top right shows steel mi
open hearth, hot strip and cold finishin

Steel Plant

OF THE FORD MOTOR COMPANY

▲ FOR ABOUT twelve years the Ford Motor Company has proceeded along the lines of a project having as its ultimate aim the installation and operation of a complete and integral steel plant, capable of producing the greater part of the iron and steel requirements of its manufacturing processes. From a comparatively modest beginning, the development of this project has proceeded until the present time finds their ultimate aim closely fulfilled.

Located on the Rouge river, the plant has the advantage of water transportation. A canal slip from the river enters the plant and provides excellent facilities for unloading and loading boats, a considerable fleet of which is owned and operated by the company. Extending along the canal slip for half a mile is a storage yard, constructed of concrete and separated into bins, with a total capacity of about two million tons. Ore, limestone and coal are stored here. Ore arrives direct by boat from the company-owned Blueberry or Imperial mines. Coal arrives also largely by boat. Three boat unloaders and two traveling bridges serve the storage yard.

The blast furnace high line, extending along the inside of the storage yard, is 40 feet high and three-quarters of a mile long, and serves the coke plant, as well as the blast furnace. Five railroad tracks are on the high line, from which cars can be unloaded directly into the service bins below.

Coke Plant

The by-product coke oven department consists of two batteries of Wilputte ovens, 60 ovens each, 16″ wide, 40′–4″ long and 12′–0″ high; one battery of 60 Semet-Solvay ovens, 19″ wide, 38′-0″ long and 10′–9½″ high; and, under construction, two batteries, each of 61 Koppers ovens, 17½″ wide, 40′–3½″ long and 13′–3″ high. The new ovens will take a charge of 18 tons of coal each, while the charge of the older ovens averages about 14.2 tons of coal each. The existing ovens are heated with coke oven gas, using about 45% of the total gas make, while the ovens under construction will employ blast furnace gas as a heating medium.

Coking time is given as 20 hours for metallurgical coke and 15 hours for domestic coke. Total production of the five batteries, when completed, will be about 4500 tons of coke per day. This output will be used in the blast furnaces and foundries, and sold, according to operations.

Striking view of blast furnaces which have an annual capacity of 550,000 tons of pig iron.

By-product recovery is carried out according to standard practice. By-product yields are given as approximately 8 gal. of tar, 2½ gal. of light oil and 19 lb. of ammonium sulphate per ton of coal, while a total gas make of 12,000 cubic feet of gas per ton of coal is claimed. Tar and surplus gas is used as fuel in the plant, while sulphate and light oils are sold. Coke breeze is burned under power house boilers.

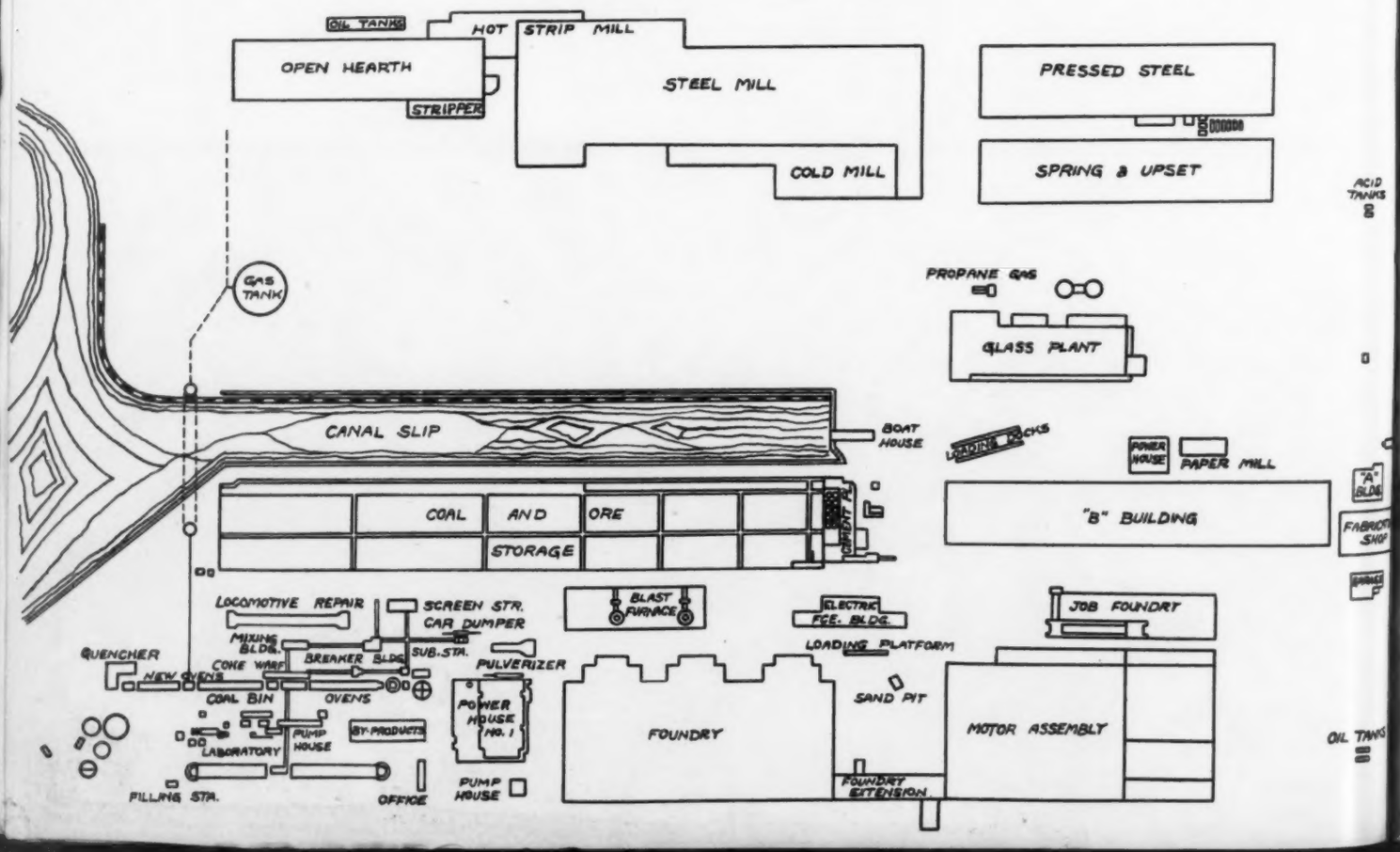
Coal charged to the ovens is a mixture of high volatile coal from mines in Kentucky, capable of producing about 3,000,000 tons annually, and low volatile coal from the West Virginia Pocohantas field. The mixing building is located along the extension of the blast furnace high line previously mentioned, from where handling proceeds entirely by conveyor, as is usual in coke plant practice.

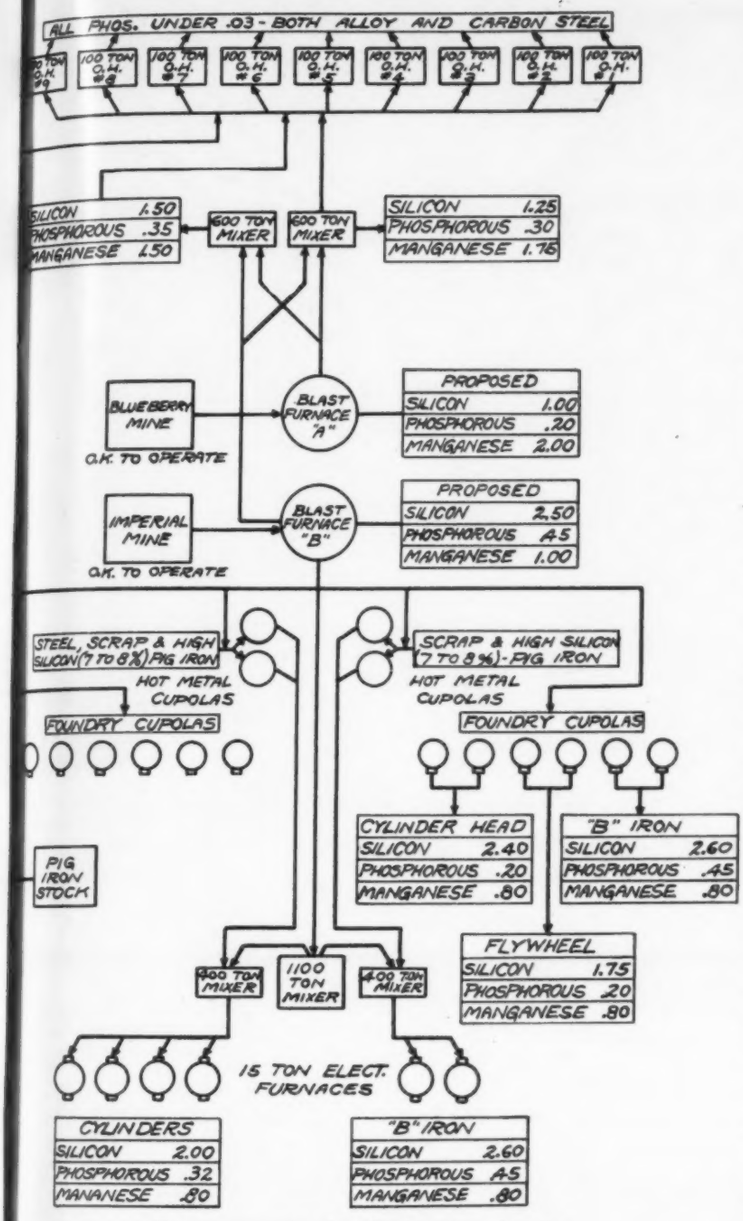
A complication in the construction of the new oven batteries involved the use of steel and concrete pilings to a depth of about 90 feet, in order to obtain a high degree of solidity of the foundations. This practice is necessary in the construction of foundations for all heavy equipment at the Rouge plant.

Blast Furnaces

There are two blast furnace stacks, each 92′–0″ high, with 18′–6″ hearth diameters and 22′–3″ bosh diameters, giving a total annual capacity of about 550,000 tons of pig iron. Each furnace has 12 tuyres, with bosh angles of 81 degrees. One furnace is usually kept on basic iron for the open hearth plant, while the other produces merchant iron for foundry use. Coke rates of 1700-1800 lb. per ton of basic iron and 1900-2000 lb.

General layout of Rouge plant.





Diagrammatic sketch showing the distribution of iron throughout the plant.

per ton of merchant iron are said to be obtained. Both of these furnaces have been enlarged and modernized in the past three years.

A rather unusual design of off-takes and downcomer is provided. Four uptakes, equally spaced and of equal length so as to offer equal resistances to gas flow, and each provided with a baffled off-take connection, converge into a single downcomer. This design is an attempt to retain large particles of material in the furnace during slips.

Each furnace is equipped with four hot blast stoves, 110′ high and 24′ in diameter, and are laid up with special tile shapes giving a heating surface of 137,000 square feet in each stove. Blast temperatures of 1000-1500 degrees F. are carried, according to furnace conditions. The stoves are equipped with pressure burners and are said to consume about 25% of the blast furnace gas made. The surplus gas is used as fuel elsewhere in the plant. The gas distribution system of this plant will be fully discussed in a paper to be presented before the 1936 *Association of Iron and Steel Engineers' Convention.* Blast furnace gas is brought to a high degree of cleanliness by dust catchers, primary washers and electrical precipitators.

Sludge from the Dorr thickener and flue dust are sintered, together with some fine ore, mill scale and borings, and re-charged into the furnaces. Usual proportions are 40% flue dust and sludge, 30% fine ores, 30% borings or 30% mill scale. The sintering plant has a capacity of about 200 tons per day.

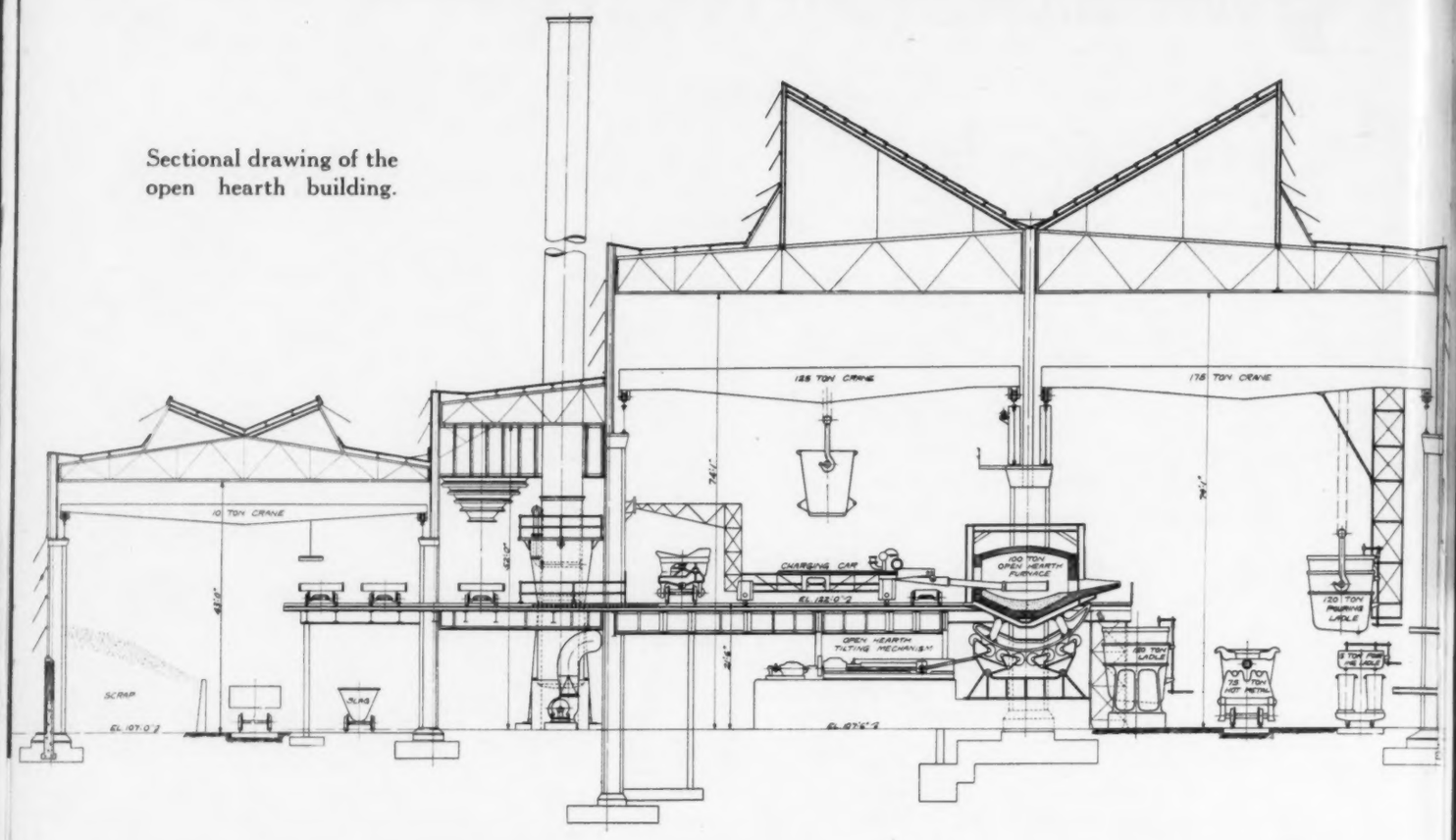
Blast for the furnaces is furnished by two turboblowers, each with a capacity of 70,000 cubic feet per minute at 35 lb. per square inch pressure.

Each furnace is usually tapped every four hours, into open top ladles of 75 tons capacity. Ten ladles are on hand. Slag thimbles have a capacity of 260 cubic feet each. Iron is transported, according to the use for which it is intended, to one of three mixers. A diagrammatic sketch of the distribution of iron throughout the plant accompanies this article.

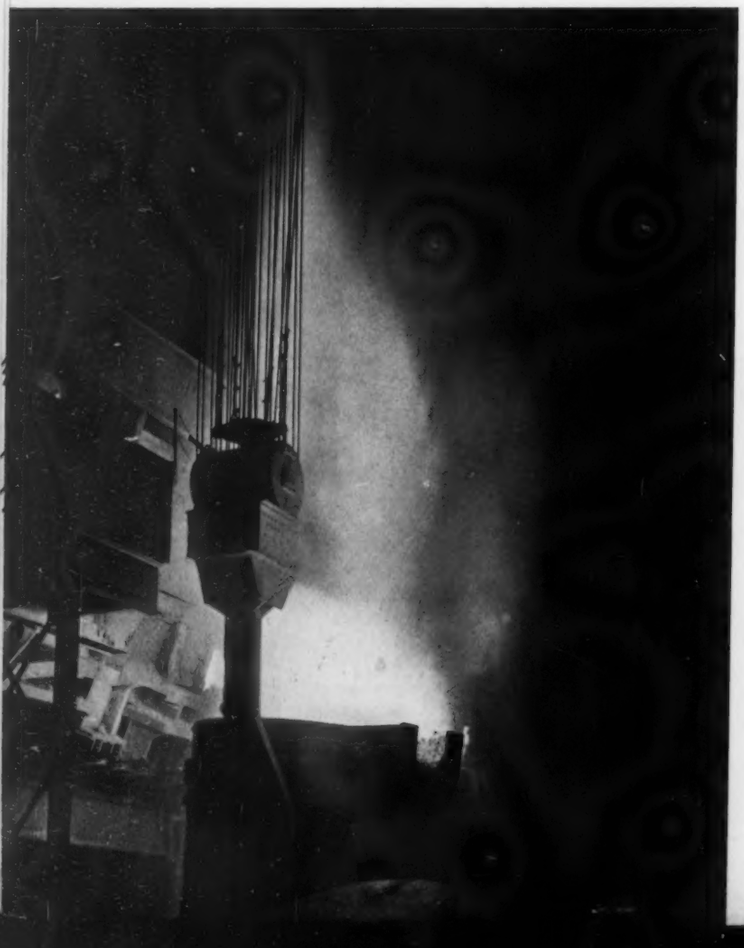
Open Hearth

The open hearth building is 240 feet wide x 1066 feet long, containing nine 100 ton furnaces, four titling and five stationary and one 400 ton tilting furnace. In the smaller furnaces hearth dimensions run 37-40 feet in

harging machine in action
open hearth department.



Sectional drawing of the open hearth building.



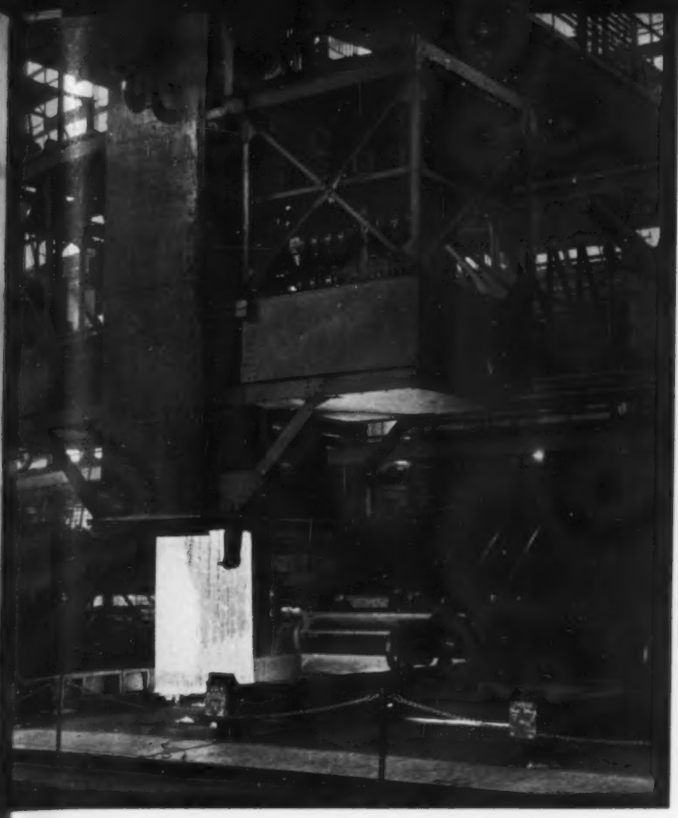
Action picture of a heat of steel being tapped into a 175 ton ladle.

length by about 15 feet in width, averaging about 550 square feet of bath area. Roofs are of sprung arch design, 13½″ thick, with 18″ ribs. Back walls are sloped. Insulation has not been carried above the charging floor. Regenerator walls are composed of 13½″ firebrick, 4½″ sil-o-cel and 9″ of second quality of fire brick. Regenerator roofs are 13½″ of firebrick, covered with 4½″ of C-3 concrete. Regenerator floors also contain 4″ of C-3 concrete. Three furnaces are equipped with combustion control.

Fuels used in the open hearth furnaces are oil, tar, or gas, depending on the supply available. Fuel consumption is stated to be the equivalent of 40-43 gallons of oil per ton, or 6-6½ million Btu per ton, with a time of heat of 11-12 hours. Waste heat boilers, of the fire tube type are installed, generating steam for power, process and heating.

Both killed and rimming steel are made, the former for bar stock and the latter for flat-rolled products. A typical open hearth charge consists of 19,500 lb. of limestone, 134,200 lb. of steel scrap, 27,800 lb. of cold iron, 78,000 lb. of hot metal and 7,000 lb. of alloys.

Heats are tapped into 120 ton ladles and handled by ladle cranes of 175 tons capacity. Originally, all ingots weighted 1500 lb. and it was for this size that the original blooming mill was designed. The new blooming



View of soaking pit crane handling ingots.

mill development, however, permits the use of larger ingots, which are of two sizes, 4500 lb. and 10 tons, the latter being particularly adapted for use through the new hot strip mill. These ingots are 22″ x 52″ x 72″ in size. About 12 of these large ingots are obtained per heat, and about 45 of the smaller size.

Hot metal to the open hearth passes through two 600 ton mixers located in the open hearth building, and is handled between mixers and open hearth furnaces by a 125 ton hot metal crane.

The open hearth stockhouse consists of a wide bay immediately adjacent to the open hearth building, on the charging floor side. The charging floor level is extended onto a balcony into the stockhouse, and it is here that all of the charges are made up. Scrap brought in on cars from the Ford plants is unloaded direct from the cars to the charging boxes on the balcony level by means of cranes and electric magnets. Scrap sheared up in the stock house is loaded into charging boxes at the side of the shears and lifted to the balcony by crane.

Limestone, fluorspar, chrome ore, dolomite, ferro-alloys, etc., are dumped from cars into a pit beneath the truck outside of the building on the stockhouse side, and carried up, by skip hoist and conveyor, to overhead steel hopper-type bins, from which the material can be put directly into charging boxes.

A sectional drawing of the open hearth building accompanies this article and will serve to elucidate on the foregoing description.

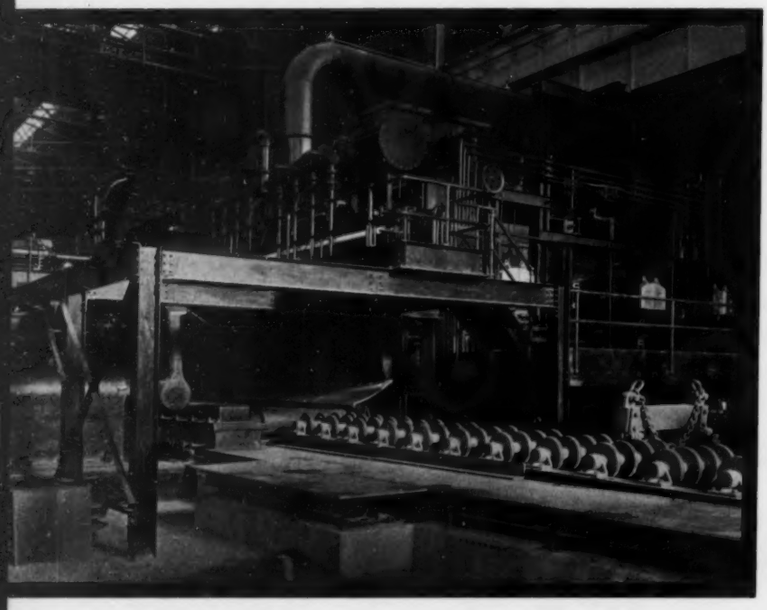
Rolling Mills

After pouring, mold drags are shifted by a fireless locomotive into the soaking pit building, where there are nine blocks of pits, originally of four holes each. A rebuilding program is now in progess on the soaking pits, changing them to three-hole blocks. Three blocks have been thus rebuilt. These pits are fired with gas or liquid fuels, depending on the supply available. When soaked, ingots are drawn by pit crane and conveyed on an ingot buggy to a roller table then to the blooming mill. The 1500 lb. ingots formerly used went directly to the original 42″ and 32″ semi-continuous blooming and billet mill. The 4500 lb. ingots pass through the new reversing bloomer and then proceed to the old bloomer, while the 10 ton ingots pass through the new bloomer and onto the hot strip mill. The plant layout is such that this procedure is rendered simple and convenient, as can be seen from the drawing accompanying this article.

The 42″ mill consists of four 2-high stands in which the small ingots are broken down to 6½″ squares. These stands are spaced on 25 ft. centers. A reduction

View of newly redesigned and erected three hole soaking pits.

of about 25% is made in each pass, and the bloom is turned between the first and second and third and fourth passes. A crop-end shear follows this mill, and the bloom proceeds to the 32″ billet mill, where it is rolled into 3⅞″ squares, 5½″ squares or 8″ x 2″ slabs as desired. There are four 2-high stands in this mill, spaced 10 ft., 25 ft., and 10 ft. apart, respectively. Twist guides turn the piece between the first and second stands, and between the third and fourth. The piece is turned on the table between the second and third stands. Both mills are driven by a common motor, 8000 H.P., 240 R.P.M., 13,200 volts, 3 phase, induction,



Discharge side of slab reheating furnaces for the 56″ continuous hot strip mill.

with phase wound rotor. This motor is located in the center of the motor room, between the last stand of the 42″ mill and the first stand of the 32″ mill, and drives from both sides through a long line shaft. The line shaft drives eight cross shafts through spiral bevel gears. Spur gears on each cross shaft reduce through other cross shafts which are connected to the mill stands through couplings and herringbone pinions.

When leaving the 32″ mill, billets, running up to 30 ft. in length, proceed across a transfer table to a 600 ton billet shear. Billets are cut into lengths of about 15 ft. and travel across a cooling bed 90 ft. long x 32 ft. wide to the chipping beds. If desired, an alternate plan allows the billets to proceed across the transfer table directly to the tables of the 18″ continuous sheet bar and billet mill. This mill consists of six stands of horizontal rolls and two vertical edgers, all driven by a 5000 H.P., 13200 volt, 100 R.P.M. induction motor. In this mill, 3⅞″ square billets are reduced to 1½″ squares, and 8½ x 2½″ slabs are reduced to 8″ sheet bar weighing about 7 lb. per foot.

The 1½″ squares from the 18″ mill may be reheated and rerolled in the 12″ spring mill, consisting of eight 2-high stands, and two vertical edgers, driven by a 1400 H.P., 500 volt variable speed DC motor, or in the 10″ rod mill, composed of sixteen stands driven by two 500 volt variable speed DC motors of 2000 H.P. and 1250 H.P., respectively.

Billets 3⅞″ square and 5½″ square from the 32″ mill may be reheated and re-rolled in the 14″ merchant mill, composed of six 18″ continuous roughing stands and four staggered 14″ finishing stands, all two-high. It is designed to produce rounds from ⅞″ to 3″ in diameter and equal sections in squares and flats. Both roughing and finishing stands are driven through bevel gears from one fully enclosed line shaft 240 ft. long, directly connected through a breaking spindle and coupling to the mill drive. The motor is a 4500 H.P., 500 volt variable speed DC motor, 67-110 R.P.M.

RECENT DEVELOPMENT

The recently completed program includes a 44″ blooming mill, a 56″ hot strip mill and cold strip mills, together with finishing equipment for the wide strip.

The 44″ reversing blooming mill, with rolls 39″ in diameter by 96″ long, takes ingots of any size from the soaking pits. The smaller ingots are broken into blooms and then proceed to the original 42″ and 32″ continuous mills, with which the new bloomer is in line. The large ingots are broken down into slabs, which proceed to the hot strip mill.

The 44″ blooming mill is driven by a 7000 H.P., 50-120 R.P.M., 750 volt DC reversing motor. DC

Delivery side of 44″ reversing blooming mill which has rolls 39″ in diameter and 96″ long.

OIL & TAR TANKS

OIL COOLING & REFRIG. STATION

OPEN HEARTH

#10 #9 #8 #7 #6 #5 #4 #3

STR

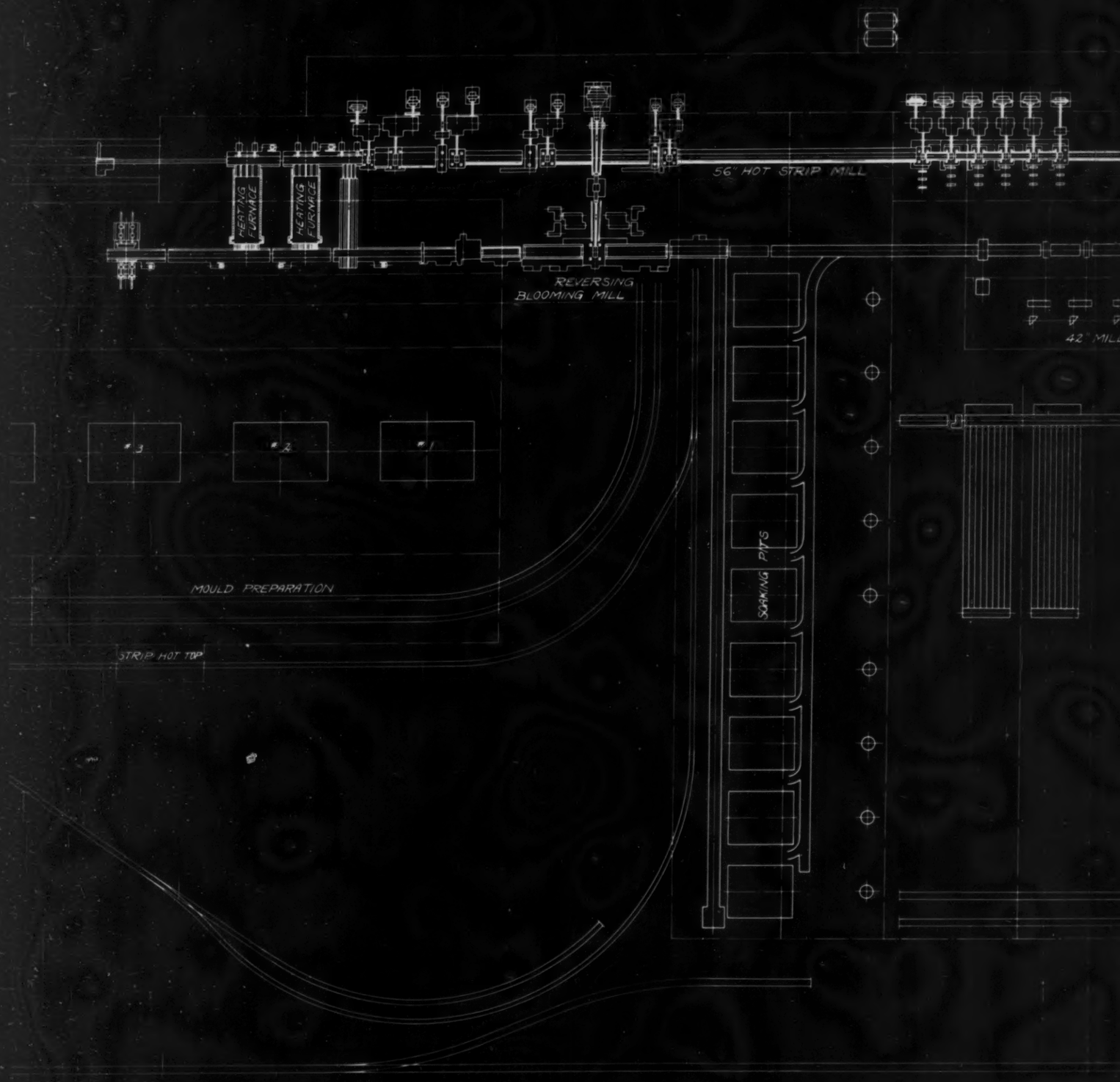
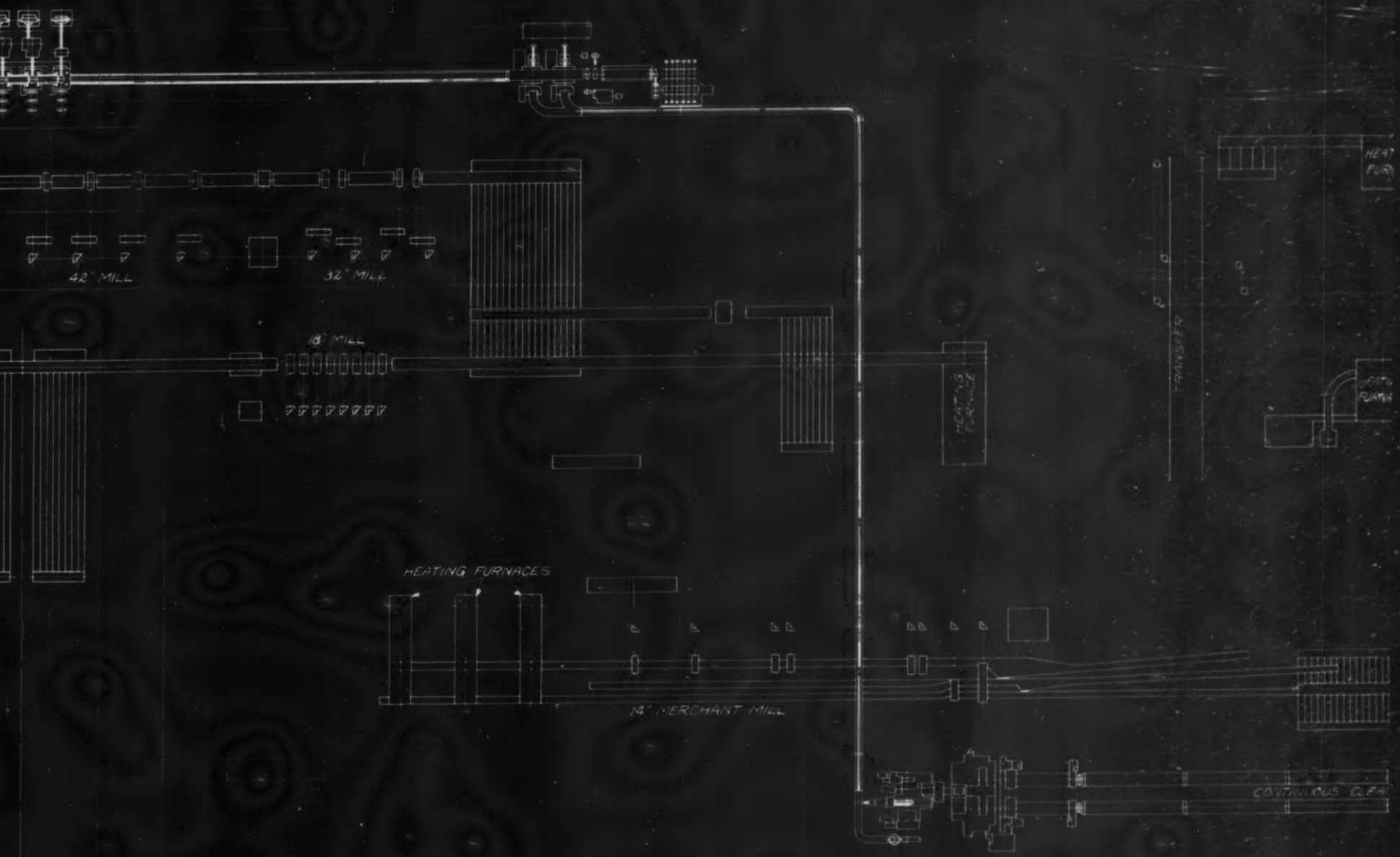


DIAGRAM OF RIVER ROUG
FORD MOTOR COMPANY



ROUGE PLANT STEEL MILL.

PANY - DETROIT, MICHIGAN.

LOADING DOCK
HEATING FURNACE
10" MILL
12" MILL
HEATING FURNACE
CONTINUOUS CLEANING
COLD MILL
BELL TYPE ANNEALING
CONTINUOUS ANNEALING

power for this motor originates in the flywheel motor generator set consisting of two 3000 KW, 360 R.P.M., 750 volt DC generators operating in parallel and an 80 ton flywheel, driven by a 5000 H.P., 13,200 volt slip-ring induction motor, which is started across the line. Rotor current in this motor is controlled by a liquid slip regulator.

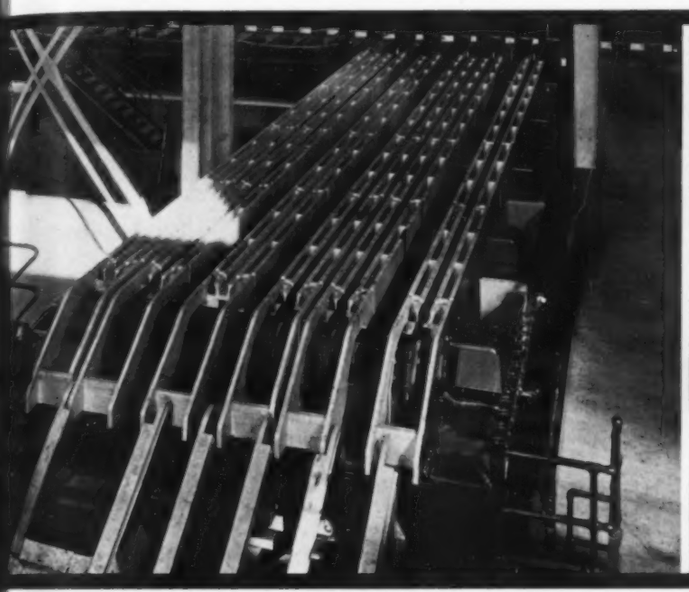
Slab Furnaces

The primary heating zones are equipped with six combination gas and oil burners across the width of the furnace above the steel, and six more below the steel. The secondary heating zone is fired with eight combination burners spaced across the width of the furnace above the steel. All combustion air is supplied to the burners through a high temperature blower which receives the air from recuperators located beneath the furnace. Recuperators are of two types, one a special shape refractory tile recuperator and the other a tubular carborundum recuperator, both of which are designed to heat air to 800° F. at rated capacity.

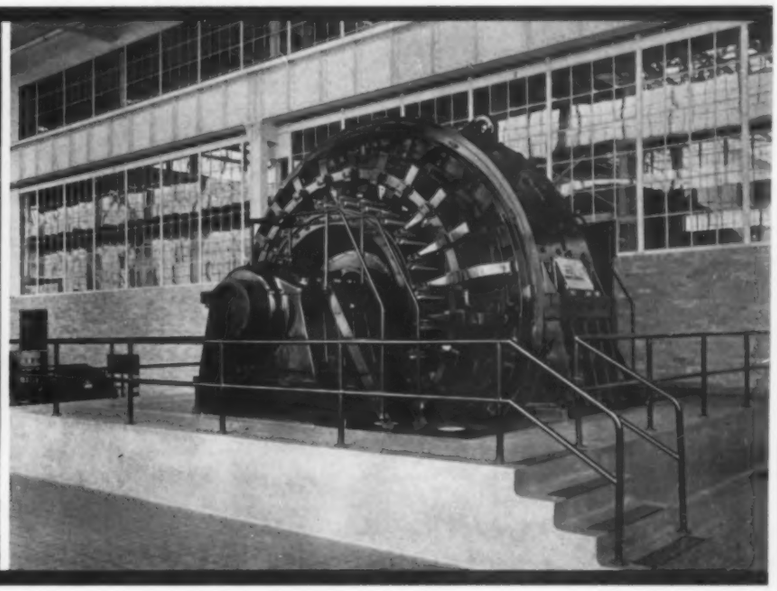
These furnaces are equipped with automatic controls on furnace pressure and fuel-air ratio, and are completely insulated and steel encased.

The hot strip mill is designed for the production of strip in widths up to 48″, and in gages down to No. 18, and is comprised of two scale breakers, three edgers, four roughing stands and five finishing stands, arranged as on the table and drawing accompanying this article.

On entering the mill a 2-high, 24″ x 56″ scale breaker gives a very slight reduction to crack primary scale, which is then removed by 1000 lb. pressure hydraulic jets. The scale breaker is driven by a 800 H.P. slip-ring motor, 590 R.P.M., 440 volts. The next stand is a 2-high, 42″ x 96″ mill driven by a 2500 H.P., 13,200 volt slip-ring motor, 593 R.P.M. Slabs up to 90″ long may be put through this mill either end-ways or broadside, the latter serving to bring the slab to a greater width. Turn tables on each side of this stand, together with side guards, put the slab into the desired position. A pusher on the entry side insures positive entry to this stand. After passing through a vertical edger, the next stand is a 2-high, 32″ x 56″ rougher, driven by a 2500 H.P., 13,200 volt, 514 R.P.M. synchronous motor, followed by a second edger. Next come two roughing stands, 4-high, 46″ and 21″ x 56″, each driven by 2500 H.P., 13200 volt, 514 R.P.M. synchronous motors. Between these two stands is a third edger.



Slab transfer table on the 56″ continuous hot strip mill.



7000 horsepower motor for driving the 44″ blooming mill.

Roughing stands are so spaced as to put the slab in but one roughing pass at a time. As a result, constant speed motors were made possible to drive these stands, at a considerable saving in cost.

Strip leaves the last rougher at a speed of about 420 feet per minute, and is ¾″ to ½″ thick, depending on the gage to be rolled. Entry to the finishing train is effected at a speed of about 150 feet per minute.

Between the last roughing stand and the finishing train is a 175 ft. long cooling table, along the greater part of which air jets are so arranged as to play upon the strip passing along the table. The purpose of this table is to provide means for equalization of temperature along the length of the strip. A constant check of the temperature is kept by means of a high speed pyrometer located at delivery side of roughing train. The table is long enough to eliminate delay in handling even the heavier gages. Temperature equalization at this point is a major factor in maintaining gages of the finished strip.

Number 3 edger and Number 4 roughing stands of the 56″ continuous hot strip mill.

The first stand in the finishing train is a scale breaker similar to that preceding the roughers, but driven by a 400 H.P., 230 volt DC motor, 300-600 R.P.M. The finishing train is composed of five 4-high stands on 18′–6″ centers, 46″ and 21″ x 56″, driven by four 3000 H.P., 550 volt DC motors, 200-400 R.P.M., and one 2500 H.P., 550 volt DC motor, 150-300 R.P.M. Loopers for taking up slack between stands are installed between the second and third, third and fourth, and fourth and fifth finishing stands, as well as the necessary side guards, entry and delivery guides. The finishing stands are completely equipped with roller bearings, designed for an operating life of 15,000 hours when working under a maximum separating force of 3,000,000 lb. at a maximum speed of 1500 R.P.M.

DC power for driving the finishing train is supplied by six motor generator sets of 1650 KW rating, 275 volts. Pairs of the generator ends are connected in series, giving three electrical units, each of 3300 KW, 550 volts. These units have been rebuilt from equipment set free by the large scale change-over from DC to AC in the motor plant.

All roll tables up to the last finishing stand are driven through line shafts with 50 H.P. motors. The runout table, 300 feet long, at the end of the mill is comprised of 130 individually driven rolls, each equipped with ½ to 1 H.P. induction motor with speed range of 320-640 R.P.M. obtained by frequency variation. Anti-friction bearings are used on this table.

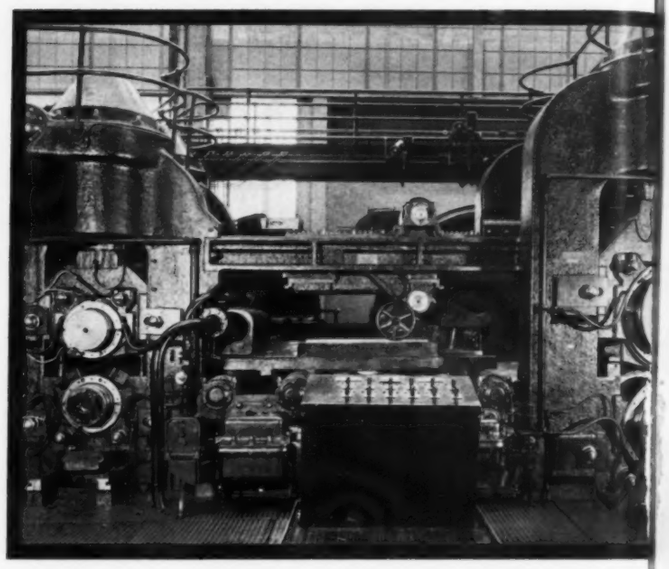
Between the last two finishing stands is a specially designed device to automatically control the tension on the strip in the last stand, giving greater precision on the finished product.

Strip leaves the finishing stands at a speed of about 1500 feet per minute and proceeds down the runout table. About 300 feet from the finishing train are two coilers, one following the other. One can coil while the other is unloading, or the strip may run over both and onto a flying shear at the end of the runout table. The flying shear is driven by a 100 H.P., 500-1200 R.P.M., 250 volt mill type DC motor, controlled automatically by photo-cells or flag switches.

Strip Finishing

Finishing processes include pickling, cold rolling, normalizing and annealing. There are two lines of pickling operations, with provisions for a third. Tanks will handle strip up to 78″ in width, and are 300 feet long, constructed of steel lined with brick and rubber. Scrubbing and drying machines follow the pickling tanks. As the process is continuous, the ends of the coils are sheared and tacked or stitched together before pickling, and again separated after pickling. Pickled strip may be either recoiled or handled flat.

Cold rolling equipment is made up of a 3-stand, 4-high tandem mill, 56″ wide, a single stand 4-high reversing mill, 84″ wide, and two stands of 2-high skin pass mills, 56″ wide. The tandem mill is driven by three 1250 H.P. motors, 300-600 R.P.M. Work rolls are 19″ in diameter by 56″ long, while back-up rolls are 49″ by 56″, all equipped with anti-friction bearings. These bearings are designed to give an operating life of 15,000 hours under a separating force of 2,750,000 lbs. at 500 R.P.M.



Close up view of the roughing stands of the continuous hot strip mill.

Strip of widths greater than that available from the hot mill can be cold rolled in the reversing mill, in which work rolls are 20½″ in diameter x 84″ long, and back-up rolls 56″ x 84″. This mill is driven by a 2000 H.P., 300-500 R.P.M. motor and is also equipped with roller bearings. This mill is designed for a separating force of 4,500,00 lb. at 350 R.P.M. with an expected operating life of 15,000 hours for the bearings.

The skin pass mills, with rolls 27½″ x 56″, are each driven by 300 H.P., 450-800 R.P.M. motors, and are designed to handle strip up to 50″ in width. Through-

out the cold rolling every effort is made to maintain gages accurately. Tension control devices are installed to take care of this important item, while cooling is effected by a specially prepared water soluble oil solution sprayed on the rolls from a circulating system.

Normalizing and annealing is done entirely in electrically heated furnaces. There is one continuous furnace 48″ wide and 227′ long, equipped with automatic zone control. Uncoiling, leveling, and stitching equipment is provided at the entry end of this furnace, while at the exit end the strip passes through pinch rolls and a shear which removes the stitching before recoiling. Extra deep drawing stock is annealed in electrically heated coil annealers of the bell type, of which there are thirty.

Annealed stock is next put through the skin-pass cold rolls, after which it proceeds either direct to the press room in coil form, or to a flying shear where it is sheared into lengths of 3½-21 feet as desired.

MISCELLANEOUS FEATURES

All stands in both hot and cold mill are driven by combination gear and pinion drives, with the exception of the last hot mill finishing stand, which has the motor connected directly to the pinion stand. The combination mounting saves floor space and contributes to the rigidity of the units. All mill and edger drives are fully enclosed, with the shafts mounted in anti-friction bearings.

Two central grease lubricating systems are installed on the hot mill, one of which provides grease lubrication under pressure to the plain bearings on the bloomer, the roughing stands of the hot strip mill, and other equipment, while the second system provides special grease for the anti-friction bearings of the strip mill. Another lubrication system supplies grease for all bearings in the cold rolls.

Oil lubrication is provided for all gear drives, pinions, motors, etc., by nine circulating systems including the continuous centrifuge equipment for oil purification. These separate systems are necessary to provide lubrication with the right kind and type of oil. Blended or mineral oils are used, depending on the service conditions of pressure, temperature or water. All gear drives and pinions use the same lubricant for both gears and bearings, the lubricant being sprayed into the meshing points of the gears, while baffles or reservoirs are provided to assure lubrication of the bearings.

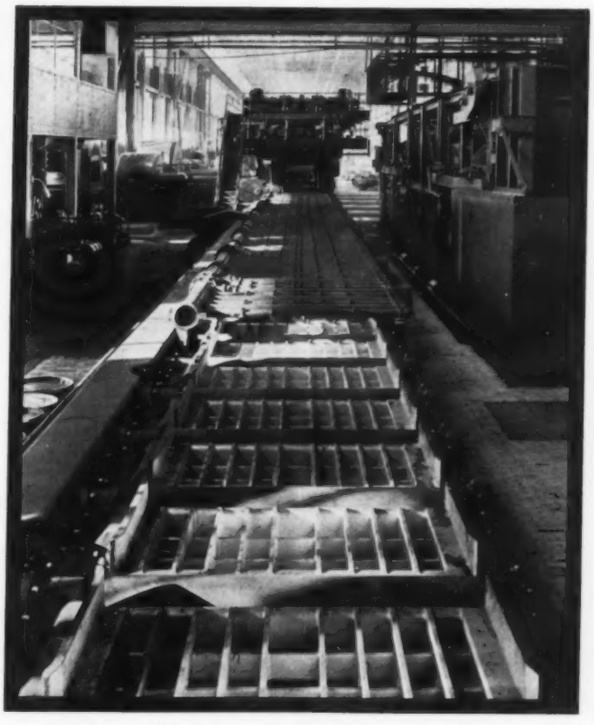
As has been noted, anti-friction bearings have been widely applied, approximately 1400 of various sizes being used.

Another feature is the wide spread use of Selsyn motors, which have been used to show position of screwdowns, gage stops, loopers, and for many other functions.

Other features are the across-the-line starting of large motors, unit type enclosed switchgear, complete metal-clad channel bus construction, and the use of non-metallic sheathed cable.

It is also to be noted that all large electrical drives and units are installed in closed motor rooms, and are ventilated from pressure basement with filtered air.

175 foot cooling table between roughing and finishing train. This table provides means for equalization of temperature the length of the strip.



View shows five 4-high stands in the finishing train. These stands are completely equipped with centralized lubricating systems.

As in all Ford projects, special attention has been given to safety and appearance. Piping and conduit have been concealed and moving parts covered where ever possible.

POWER

The addition of the new steel mill equipment has resulted in an added power load of about 30,000 KW. In order to meet the new requirements, it was necessary to increase power plant capacity. The station now consists of three 30,000 KW, one 15,000 KW, and two 110,000 KW turbo-generators, one of the 110,000 KW units and the 15,000 KW unit having just been completed.

The new 110,000 KW unit is similar to the previous unit, being a vertical compound unit, with the high pressure turbine and generator mounted on top of the low pressure units. Each unit is of 55,000 KW capacity, making the total rating 110,000 KW at 80% power factor, 13,800 volts, 1800 R.P.M., 3 phase, 60 cycle. This type of unit was employed because of space considerations, occupying less than ¼ of a cubic foot per KW of capacity. Steam is supplied to the turbines at 1200 lb. pressure, 900 degrees F. temperature, making this plant the largest high pressure industrial power plant in the world, and the only plant to operate at this temperature.

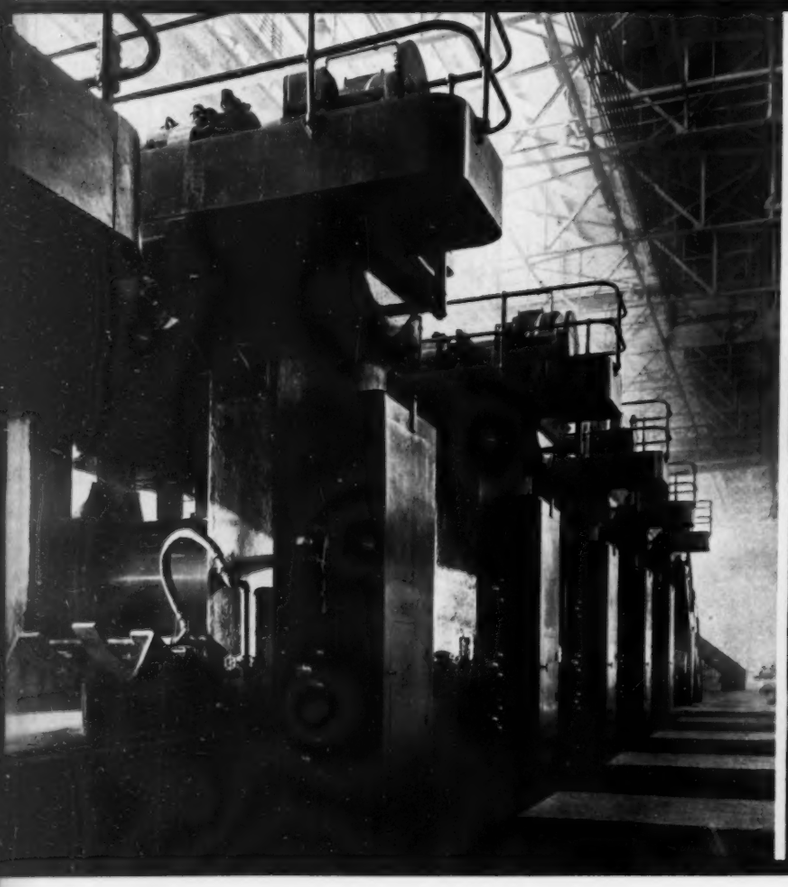
This unit is served by a single pass 73,000 square feet surface condenser, with welded steel shell, tube heads of Muntz metal, 17′–6″ in diameter by 1½″ thick, and 11,388 tubes of Admiralty metal, ⅞″ in diameter, No. 18 BWG. This condenser is designed to condense 675,000 lb. per hour of exhaust steam with a back pressure of 1″ Hg. absolute, when supplied with 117,400 gallons per minute of water at 59° F.

Circulating pumps consist of two 54″ vertical centrifugal pumps, 300 R.P.M., each with capacities of 58,700 gallons per minute against a total head of 18.4 feet, requiring 325 brake H.P. to drive or 69,200 gallons per minute against an 11 feet head, requiring 260 brake H.P.

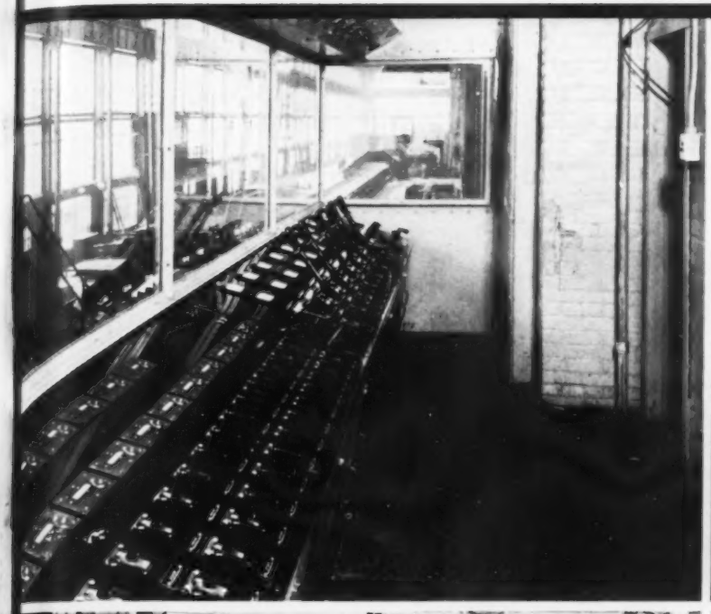
Condensate pumps are two 10″ horizontal 3-stage centrifugal pumps, with capacities of 2000 gallons per minute at 200 feet, head, 900 R.P.M., requiring 149 brake H.P. to drive.

The 15,000 KW turbo-generator takes steam at 1200 lb. pressure, and operates non-condensing, exhausting

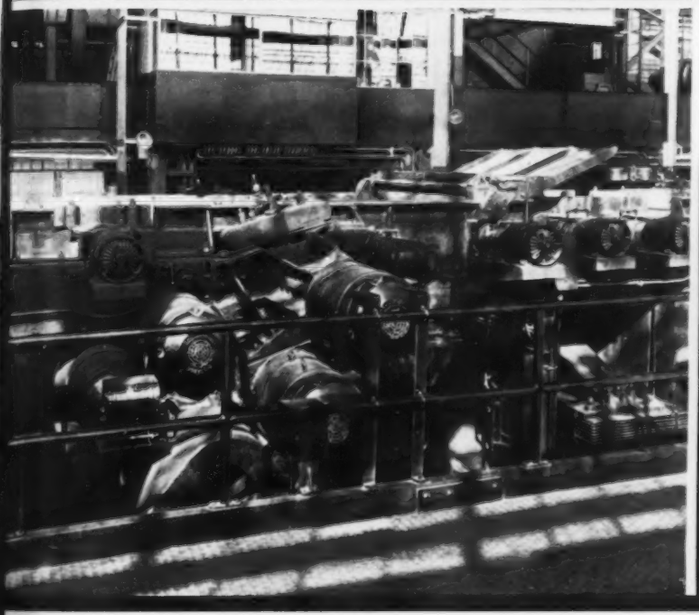
Steel in the finishing stands which leaves these stands at about an average speed of 1500 feet per minute



Another view of finishing train with screwdowns in sharp outline as well as gear and pinion drives.



(Top) Finishing mill operators pulpit for the 56" continuous hot strip mill.



Drive side of coilers on 56" continuous hot strip mill.

(Top) Motor room for the 56" continuous hot strip mill.

Roll grinder for 56" continuous hot strip mill.

against 250 lb. pressure to supply steam for use in evaporators.

To supply steam to the new turbines, a new steam generating unit was installed. The history of boiler development in this house is very interesting, and well worth a brief consideration. The initial boiler installation in this station, made in 1920, consisted of four boilers of 26,470 square feet of heating surface each. They were bent-tube double-set units, each with a capacity of about 200,000 lb. of steam per hour, at 250 lb. pressure, 600° F. temperature and burned blast furnace gas and pulverized coal. In 1923, four more units were added, duplicating the first four. Due to the need for more steam, one of these units was remodeled in 1925. Water cooled walls, radiant superheaters and additional burners were installed, together with air preheaters and additional fan capacity, giving a new capacity of 500,000 lb. of steam per hour. This unit was so successful that, in 1926, three more units were likewise remodeled.

(Left) Delivery side of 3-stand, 4-high tandem cold mill.

(Top Right) View of motor room for cold

(Right Center) Battery of 25 electric bell type coil annealing furnaces.

Continued expansion of the Rouge plant called for still more steaming capacity, with the result that the years 1930-31 witnessed the replacement of two of the old original boilers with new high pressure units. These new units were designed to produce up to 700,000 lb. of steam per hour at 1400 lb. pressure and 750° F. It was at this time that the first 110,000 KW turbo-generator was installed.

The latest expansion brought the installation of the new steam generating unit in place of one of the old original boilers. This unit, which is by far the greatest capacity high pressure unit, is designed to produce up to 900,000 lb. of steam per hour at 1400 lb. pressure, 900° F. temperature. Five forged steel drums, with welded heads, are employed in this double-set, bent-tube boiler. Heating surface is 30,000 square feet. The furnace, with a 30,000 cubic feet volume, is water-cooled, affording a fin-tube surface of 7,200 square feet. Superheating surface totals 21,940 square feet, while the economizer section contains 25,300 square feet. The economizers, of which there are two, are of horizontal fin-tubes, counter-flow. Economizer tubes are 2″ outside diameter, No. 3 BWG with an effective length of 26 feet. Air heaters, of which there are two are of the vertical plate counter-flow type, and give a total heating surface of 86,000 square feet.

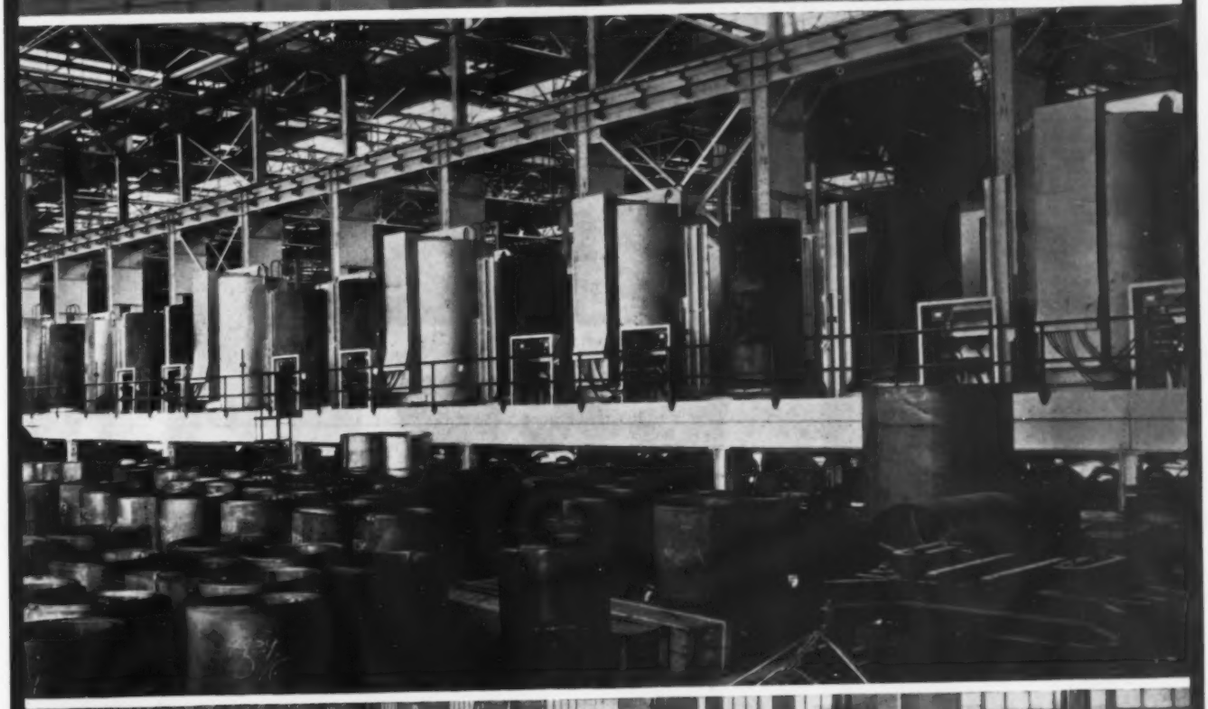
The efficiency curve of this unit is unusually flat, giving values, as follows:

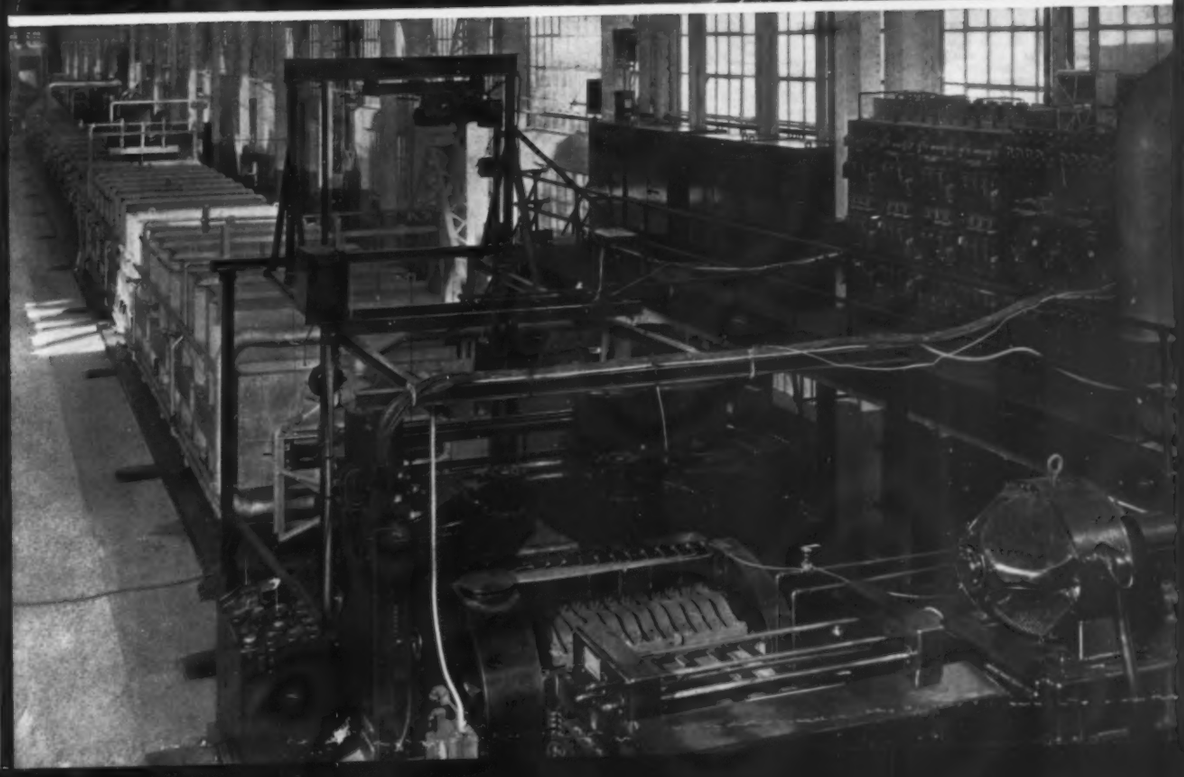
	Overall Efficiency
400,000 lb. steam per hour.....	87.7%
600,000 lb. steam per hour.....	87.8%
800,000 lb. steam per hour.....	87.4%
900,000 lb. steam per hour.....	86.6%

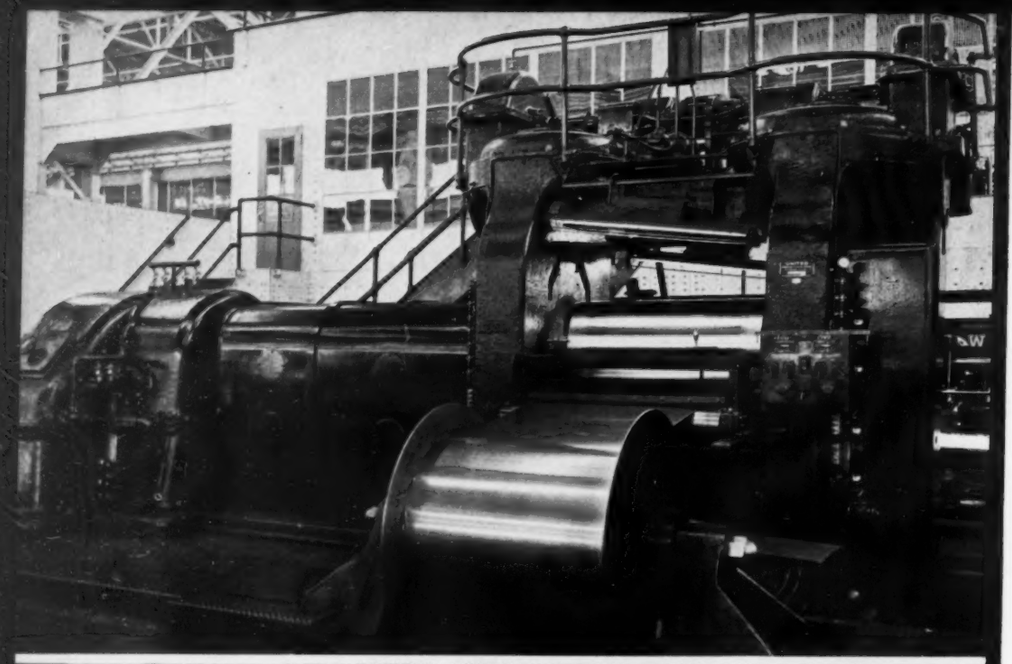
A remarkable feature of this boiler installation is the fact that, through all of the increases in capacity, resulting in a new output of about three times the original capacity, the floor space occupied by the eight units has remained constant, while the weights of the boilers per unit of capacity has decreased from the original of 298 lb. per boiler H.P. to a low of 140 lb. per boiler H.P. in the newest unit.

(Right) Continuous strip normalizing furnace which is 48″ wide and 227′ long

Close up of cold mill showing control apparatus.

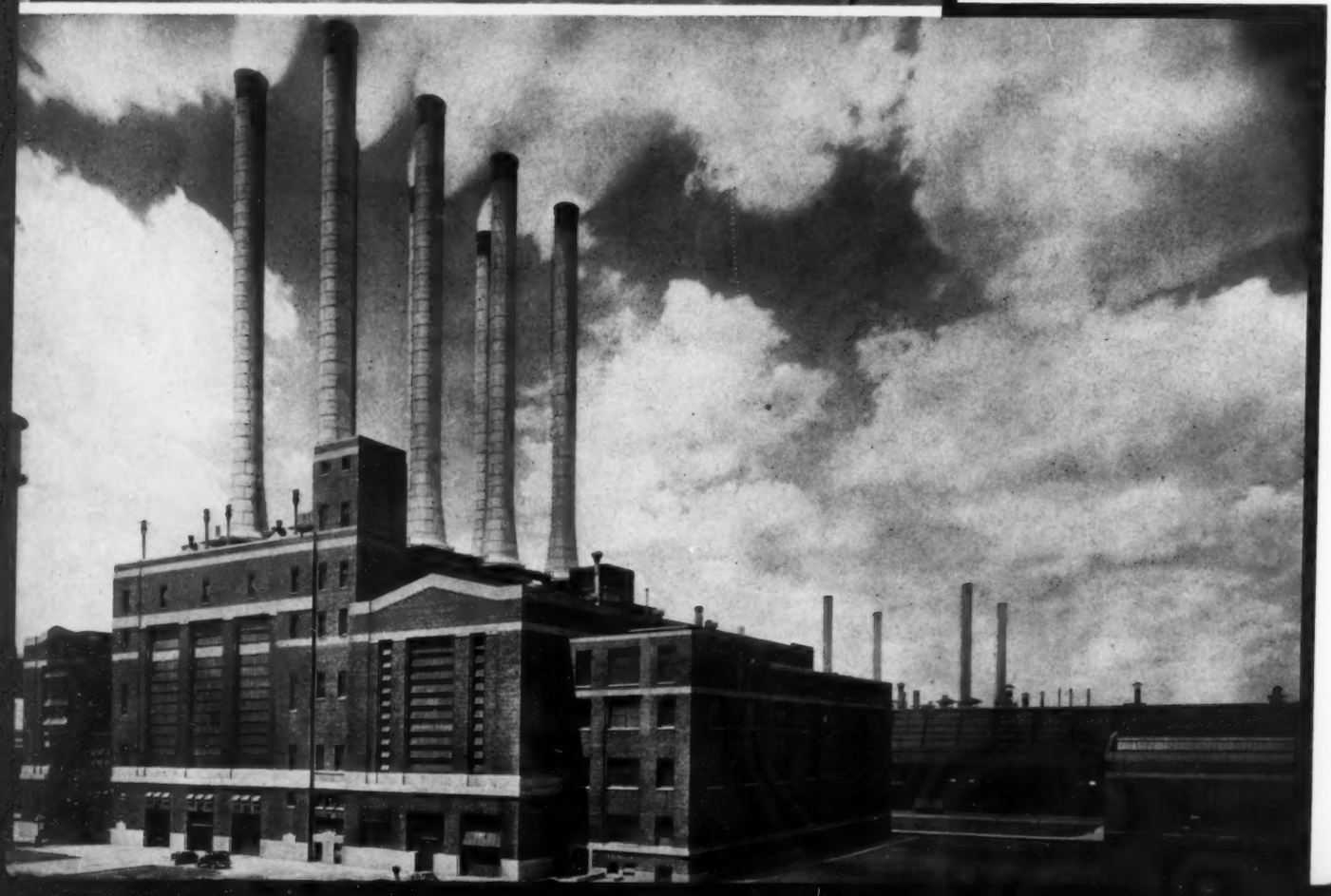






56″, 2-high skin pass mill.

Continuous pickler 300′ long and 78″ wide. These tanks are steel constructed and lined with brick and rubber.



View of Ford Power plant one the most modern in the world.

The new unit is equipped to burn blast furnace gas, coke oven gas, pulverized coal or liquid fuel, either singly or in combination. A heat liberation of 34,000 Btu. per hour per cubic foot of furnace volume may be attained.

Coal is pulverized in a central plant containing ten high speed mills and two ball mills, and having a capacity of 180 tons per hour, with 65% through a 200 mesh. Some coke breeze may be mixed with the coal to be pulverized, such mixtures being ground on the ball-type mills. A bucket elevator and screw conveyor carry the powdered coal to overhead bins.

A complete layout of meters, gages, recorders and controls provides automatic control of combustion, fuel feed, water feed and superheat, and furnishes a continual indication of all important phases of the operations.

The new unit is expected to make a KWH on less than one pound of coal or its equivalent.

In addition to the main power station, there is a plant, termed No. 3 Power House, containing twelve 400 H.P. boilers, each fired with a chain grate stoker, burning coke breeze and waste sawdust. This plant produces about 200,000 lb. of steam per hour, which is used chiefly in three small turbo-generators of 5000, 2000 and 500 KW, respectively.

Open hearth waste heat is used in seven 500 H.P. fire-tube boilers, generating about 60,000 lb. of steam per hour. Waste heat developments are also located in the glass plant and cement plant. In the latter, two 800 H.P. boilers generate about 50,000 lb. of steam per hour which is used principally in three 750 KW turbo-generators.

In the past, an annual power generation of 702,210,000 KWH has been attained, with monthly peaks of about 65,000,000 KWH, and with the new additions these figures will be considerably exceeded. The distribution of these amounts of power represent a considerable problem in itself, while the distribution of other services is even more difficult. An underground tunnel about 1½ miles long connect all main buildings of the Rouge plant. This tunnel is 12 feet wide by 9 feet high, and contains one 12″ line and one 20″ line for process steam at 180 lb. gage pressure, one 16″ city water line, one 16″ mill water line, one 10″ compressed air line, and 12″ and 16″ hot water pipes. This grouping of pipes adds greatly to economy of operation and maintenance of the service systems. A further idea of the magnitude of these operations may be gained from the fact that the water requirements of the Rouge plant are said to be 538,000,000 gallons per day. To supply this quantity it was necessary to build a large supply tunnel to the Detroit River, 1¾ miles away.

ROLLING MILL DATA

Mill	Characteristics	Roll Dia.	Roll Length	H.P.	Volts	Motor R.P.M.	Type	Type of Drive
42″ Blooming Mill	2-high, 4-stands	42″	42″	8000	13200	240	Induction	Geared
32″ Billet Mill	2-high, 4-stands	32″	60″					
18″ Billet and Sheet Bar Mill	2-high, 6-stands	18″	22″	5000	13200	100	Induction	Geared
14″ Merchant Mill	2-high, 10-stands	14″	28″	4500	500	67–110	DC	Geared
12″ Spring Mill	2-high, 8-stands	12″	19½″	1400	500	550–450	DC	Geared
10″ Rod Mill	2-high, 16-stands	10″	16″	2000	500	1375–275	DC	Geared
				1250	500	300–550	DC	Geared
NEW UNITS								
44″ Blooming Mill	2-high, 1-stand	39″	96″	7000	750	50–120	DC	Reversing
Hot Strip Mill								
Scale Breaker	2-high, 1-stand	24″	56″	800	440	590	Slip Ring	Geared
Broadside	2-high, 1-stand	42″	96″	2500	13200	593	Slip Ring	Geared
Edger	Vertical, 1-stand			600	230	400–800	DC	Geared
Rougher	2-high, 1-stand	32″	56″	2500	13200	514	Synchronous	Geared
Edger	Vertical, 1-stand			600	230	400–800	DC	Geared
Rougher	4-high, 1-stand	46″ & 21″	56″	2500	13200	514	Synchronous	Geared
Edger	Vertical, 1-stand			150	230	400–800	DC	Geared
Rougher	4-high, 1-stand	46″ & 21″	56″	2500	13200	514	Synchronous	Geared
Scale Breaker	2-high, 1-stand	24″	56″	400	230	300–600	DC	Geared
Finishing Stand	4-high, 1-stand	46″ & 21″	56″	3000	550	200–400	DC	Geared
Finishing Stand	4-high, 1-stand	46″ & 21″	56″	3000	550	200–400	DC	Geared
Finishing Stand	4-high, 1-stand	46″ & 21″	56″	3000	550	200–400	DC	Geared
Finishing Stand	4-high, 1-stand	46″ & 21″	56″	3000	550	200–400	DC	Geared
Finishing Stand	4-high, 1-stand	46″ & 21″	56″	2500	550	150–300	DC	Geared
Cold Mills								
Tandem Mill	4-high, 3-stands	49″ & 19″	56″	(3) 1250	500	300–600	DC	
Reversing Mill	4-high, 1-stand	56″ & 20½″	84″	2000	500	300–500	DC	
Skin Pass Mills	2-high, 2-stands	27½″	56″	(2) 300	500	450–800	DC	

INSPECTION TRIP

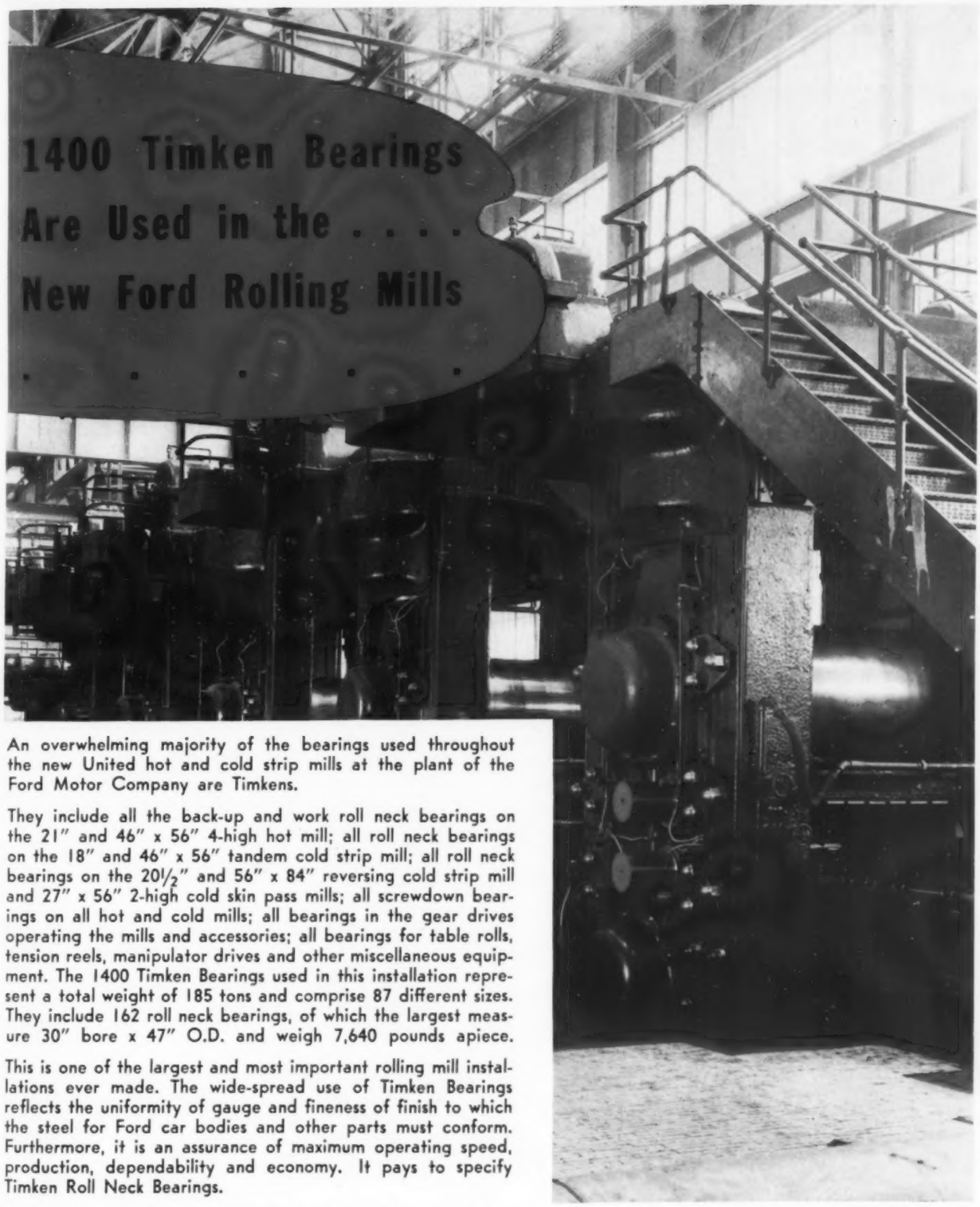
Ford Motor Company

Steel Plant, Rolling Mills and Assembly Lines

FRIDAY, SEPT. 25 - 9:15 A. M. - $2.00 per person

Make Reservation Early and Secure tickets at Registration Desk, Hotel Statler or at Iron and Steel Exposition, Cass Ave.

Trip must be made in special buses in order to secure entry to the plant.



An overwhelming majority of the bearings used throughout the new United hot and cold strip mills at the plant of the Ford Motor Company are Timkens.

They include all the back-up and work roll neck bearings on the 21" and 46" x 56" 4-high hot mill; all roll neck bearings on the 18" and 46" x 56" tandem cold strip mill; all roll neck bearings on the 20½" and 56" x 84" reversing cold strip mill and 27" x 56" 2-high cold skin pass mills; all screwdown bearings on all hot and cold mills; all bearings in the gear drives operating the mills and accessories; all bearings for table rolls, tension reels, manipulator drives and other miscellaneous equipment. The 1400 Timken Bearings used in this installation represent a total weight of 185 tons and comprise 87 different sizes. They include 162 roll neck bearings, of which the largest measure 30" bore x 47" O.D. and weigh 7,640 pounds apiece.

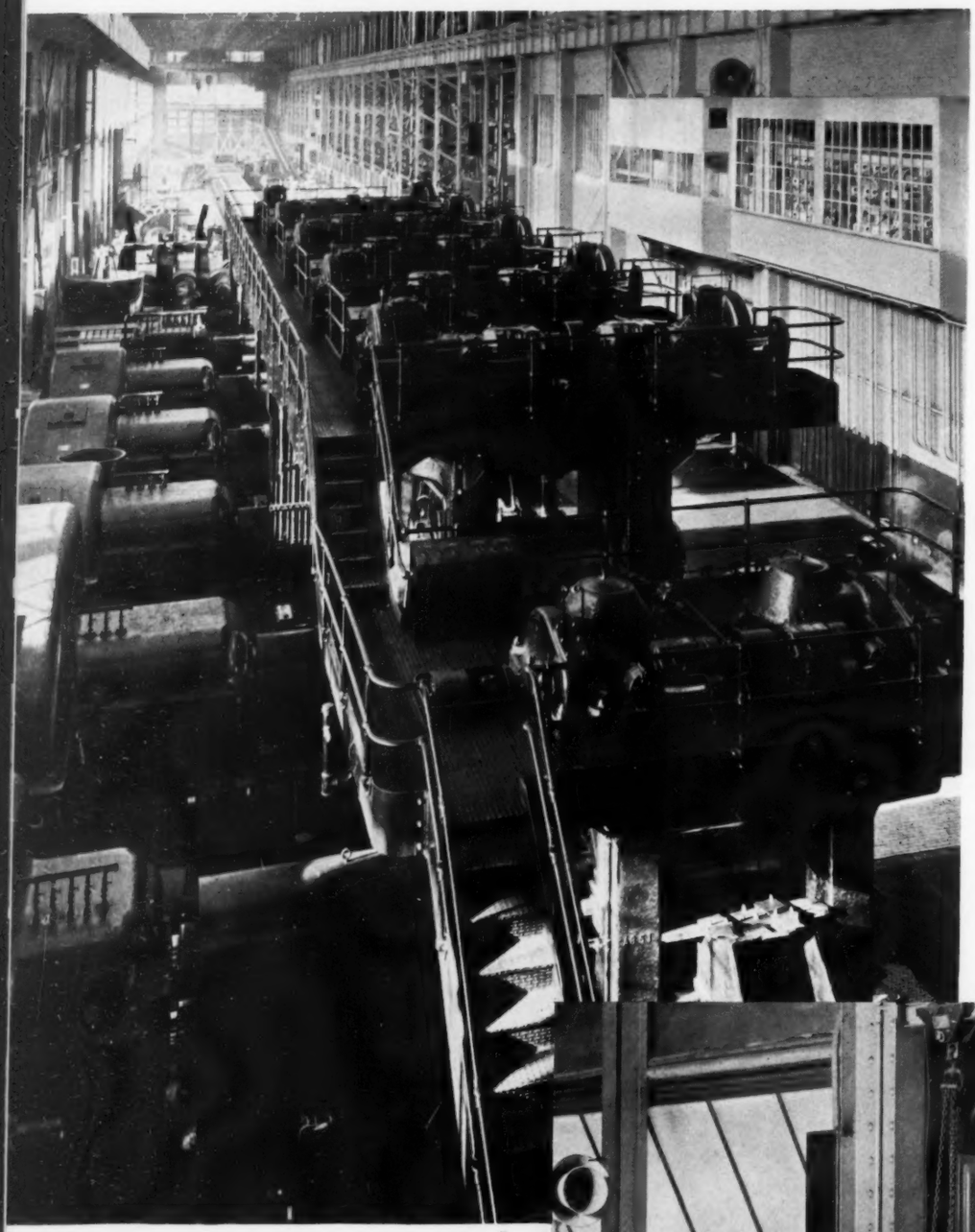
This is one of the largest and most important rolling mill installations ever made. The wide-spread use of Timken Bearings reflects the uniformity of gauge and fineness of finish to which the steel for Ford car bodies and other parts must conform. Furthermore, it is an assurance of maximum operating speed, production, dependability and economy. It pays to specify Timken Roll Neck Bearings.

THE TIMKEN ROLLER BEARING CO., CANTON, OHIO

5-Stand Finishing Train, New Ford Mill.

TIMKEN *TAPERED ROLLER* **BEARINGS**

MODERN DE LAVAL LUBRICATION SY



The illustration at the left shows the 56 Hot Strip Mill at the Ford Motor Co., Rive Rouge. Below are listed some of the othe complete Mill lubrication systems also e gineered by De Laval.

FORD MOTOR CO., Detroit
- 44" Blooming Mill
- 56" Hot Strip Mill
- 84" Cold Reversing Mill
- 56" Tandem Cold Mill
- 2 Tempering Mills

BETHLEHEM STEEL CO., Lackawanna
- 79" Hot Strip Mill
- 75" Tandem Cold Mill
- 42" Tandem Cold Mill
- 90" Tempering Mill
- 2-75" Tempering Mills
- 54" Skin Pass Mill

BETHLEHEM STEEL CO., Sparrows Point
- 42" Tandem Cold Mill
- 2 Tempering Mills

WEST LEECHBURG STEEL CO.
- 4 Steckel Cold Reversing Mills

ZAPOROJSTAL STEEL WORKS, U.S.S.R.
- 66" Hot Strip Mill
- 66" Tandem Cold Mill
- 66" Cold Reversing Mill

GRANITE CITY STEEL CO.
- 90" Hot Strip Mill
- 48" Cold Reversing Mill

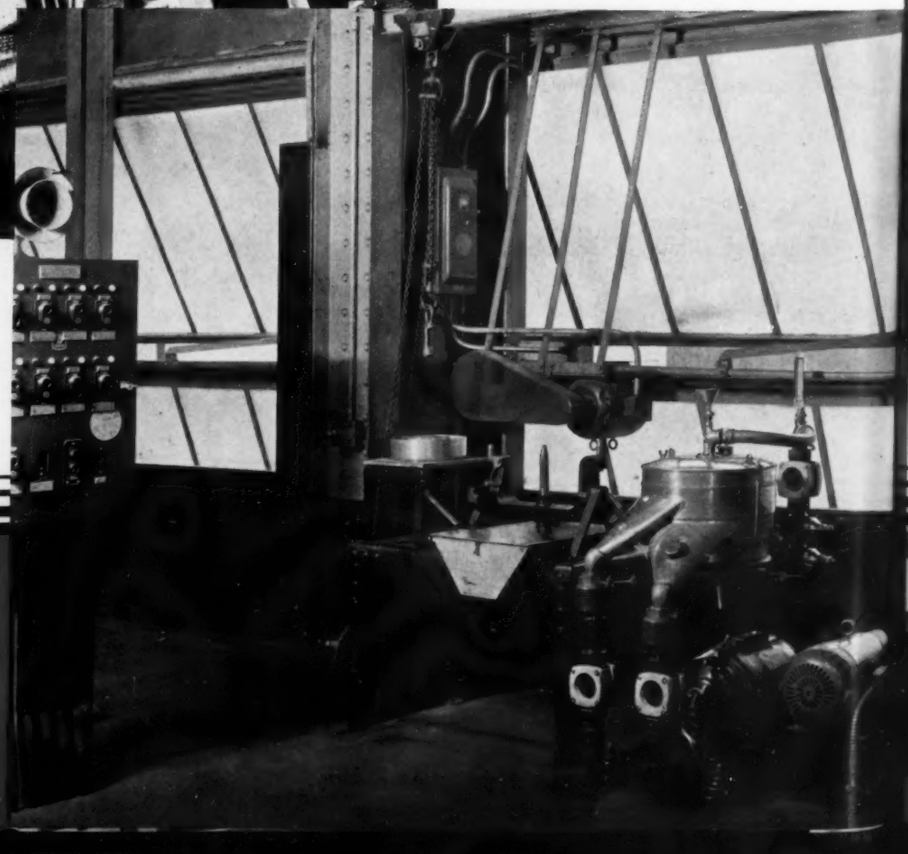
CARNEGIE-ILLINOIS STEEL CORPORATION, Homestead
- 100" Semi-Continuous Sheared Plate Mill

AMERICAN STEEL & WIRE CO., Cleveland, Ohio
- Hot Strip Mill

AMERICAN STEEL & WIRE CO., Joliet, Ill.
- 2 High Speed Rod Mills

De Laval engineered lubrication systems provide not only sufficient oil for lubrication but also a pre-calculated excess for the cooling of running parts—all lubricant being continuously maintained in a dehydrated and clean condition. Both the quantity and temperature of the oil are automatically controlled.

The illustration at the right shows one of the De Laval Centrifuges in operation at the Ford plant. Smaller illustrations on the opposite page show some of the oil piping and oil cellars as laid out by De Laval.



SYSTEMS ON NEW FORD MILLS

ALL of the new mills recently built by United Engineering & Foundry Co., and installed for the Ford Motor Company at its River Rouge plant are exclusively and completely equipped with seven modern De Laval centralized pressure lubrication systems.

• • •

See these De Laval Lubrication Systems when you visit the Ford plant. They are designed in accordance with advanced engineering standards, and you will be interested in their compactness and in the many innovations of design which increase lubrication efficiency.

SYSTEM NO. 1 Lubricates meshing points and bearings of pinion stand, rack and manipulator drives of the 44" Blooming Mill.

SYSTEM NO. 2 Lubricates meshing points and bearings of drives of reversing tables, bearings of table rollers proper and moving parts of screwdown mechanism—all of the 44" Blooming Mill.

SYSTEM NO. 3 Lubricates meshing points and bearings of combination reduction gear drives and pinion stands of Roughing Train of the 56" Hot Strip Mill.

SYSTEM NO. 4 Lubricates meshing points and bearings of combination reduction gear drives and pinion stands of Finishing Train of the 56" Hot Strip Mill.

SYSTEM NO. 5 Lubricates meshing points and bearings of pinions and bevel gears of underdriven Edgers Proper of Roughing Train of 56" Hot Strip Mill.

SYSTEM NO. 6 Lubricates meshing points and bearings of main combination reduction gear drives and pinion stands and of reel reduction gear drive—all of the 56", 4-High, 3-Stand, Tandem Cold Strip Mill.

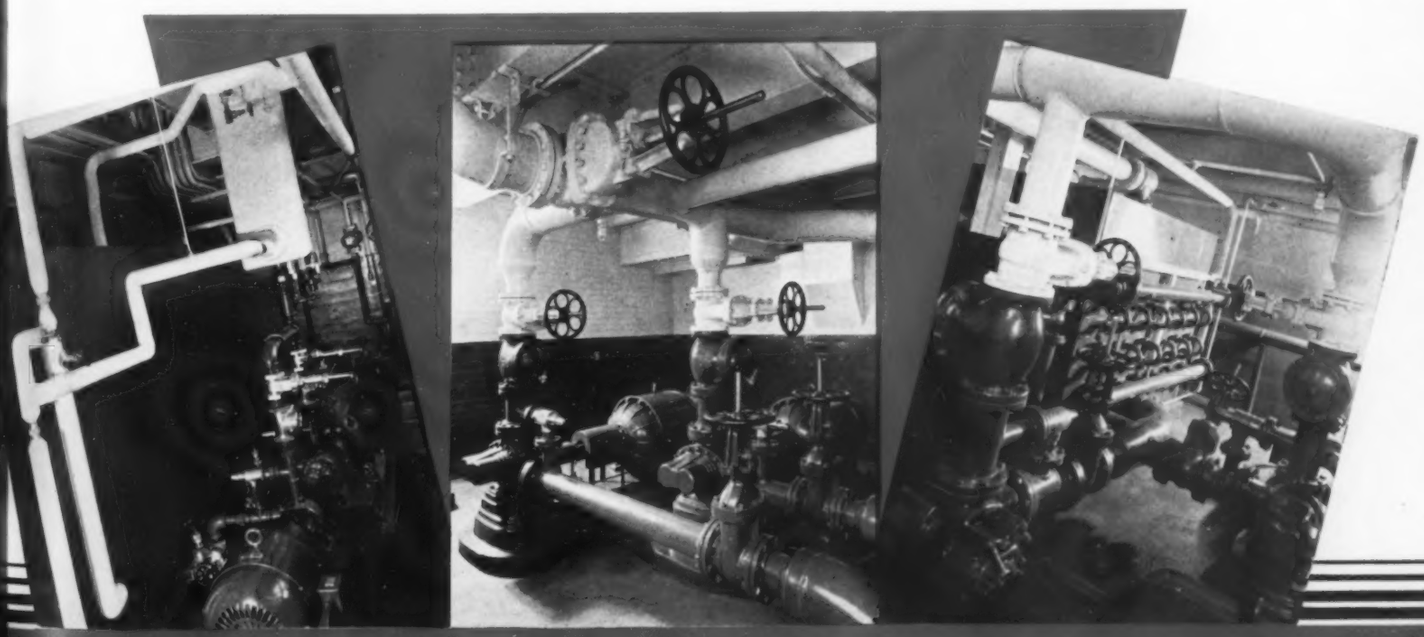
SYSTEM NO. 7 Lubricates meshing points and bearings of main combination reduction gear drive and pinion stand and of two reel reduction gear drives—all of the 84", 4-High, Cold Reversing Mill. Also lubricates meshing points and bearings of reduction gear drives of two Tempering Mills.

Continuous by-pass centrifugal dehydration combined with 100% continuous filtration of lubricants used in all systems provides the maximum assurance of properly maintained lubrication.

An inspection will demonstrate the automatic operation and compactness of design of the installation as a whole.

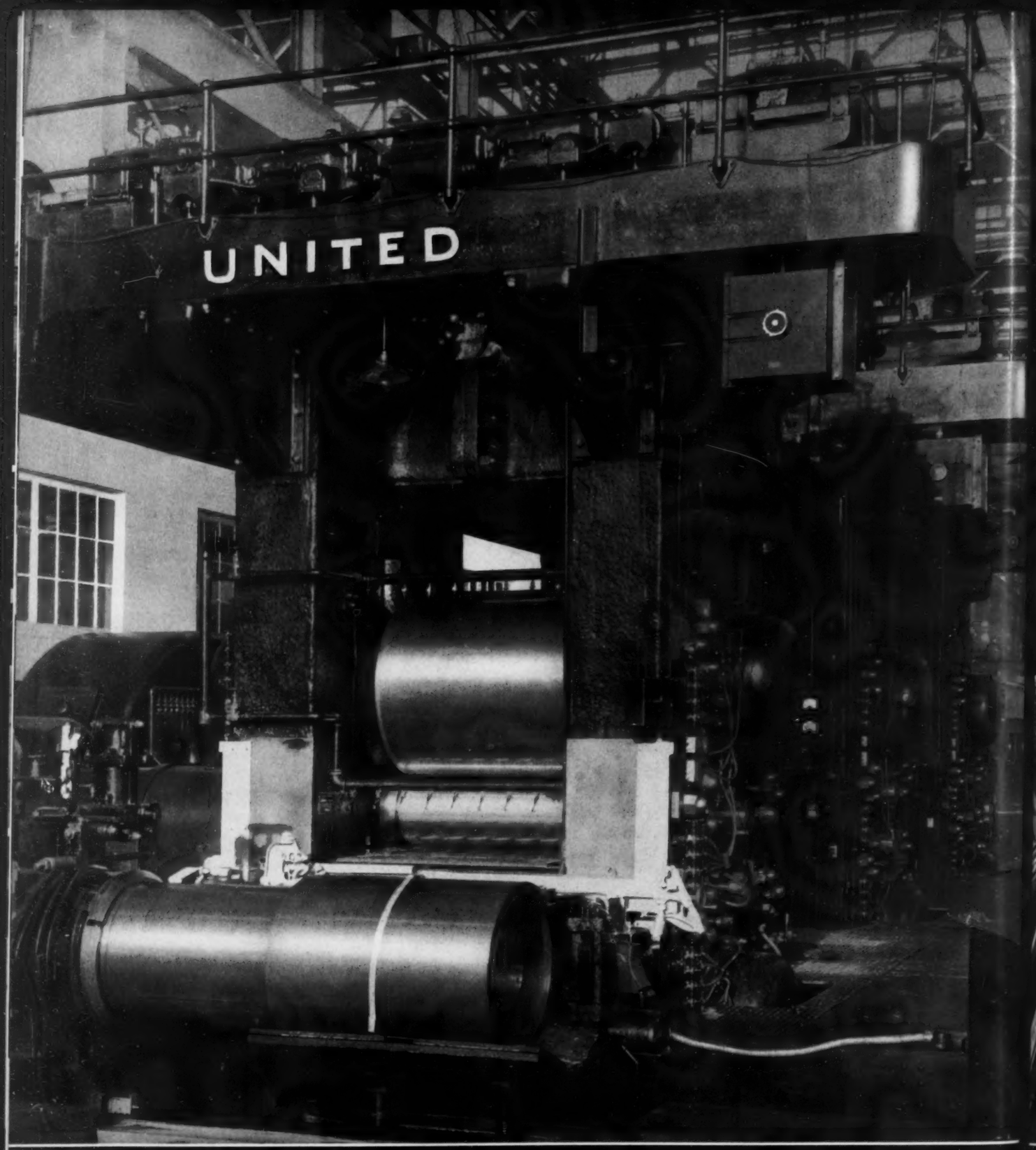
THE DE LAVAL SEPARATOR CO.

165 Broadway, New York 427 Randolph St., Chicago
De Laval Pacific Company, 61 Beale St., San Francisco
De Laval Sales & Service, Inc., 86 Mayfair Drive
Mt. Lebanon, Pittsburgh



MODERN LUBRICATION SYSTEMS *Engineered by*

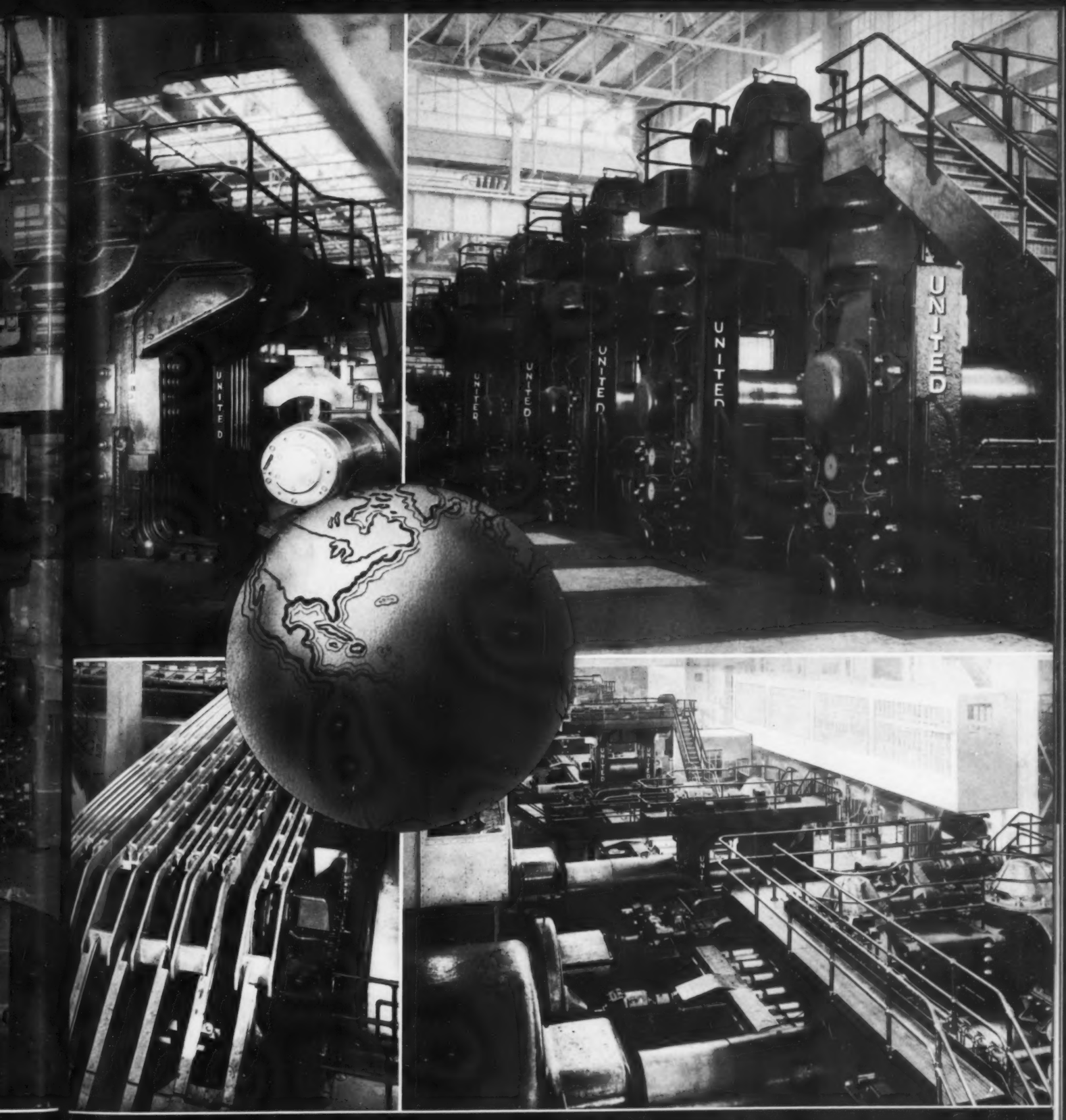
DE LAVAL



★ WORLD-WIDE P

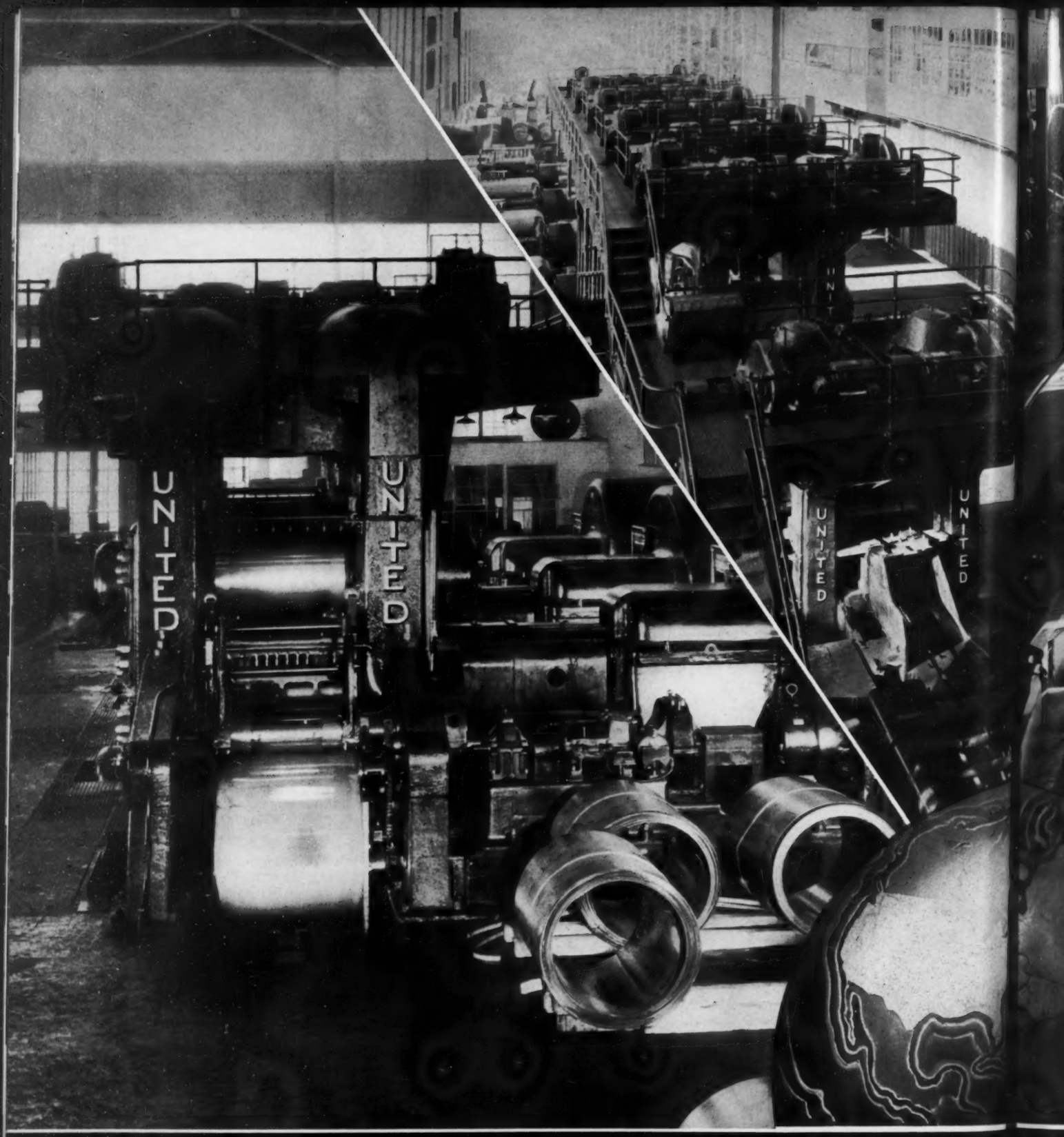
During the inspection trip of the Iron & Steel Engineers Association through the Ford Mill, you will see UNITED'S latest contribution in design, engineering and construction of modern 4-High Hot and Cold Strip Mills.

When you see these mills in operation you may visualize a duplicate installation in the U.S.S.R. at Zaporojstal and another duplication for Richard Thomas, Ltd., Ebbw Vale, Wales, both of which are now under construction.



EPREFERENCE ★

ation
alla-
and
ard
both
tion.

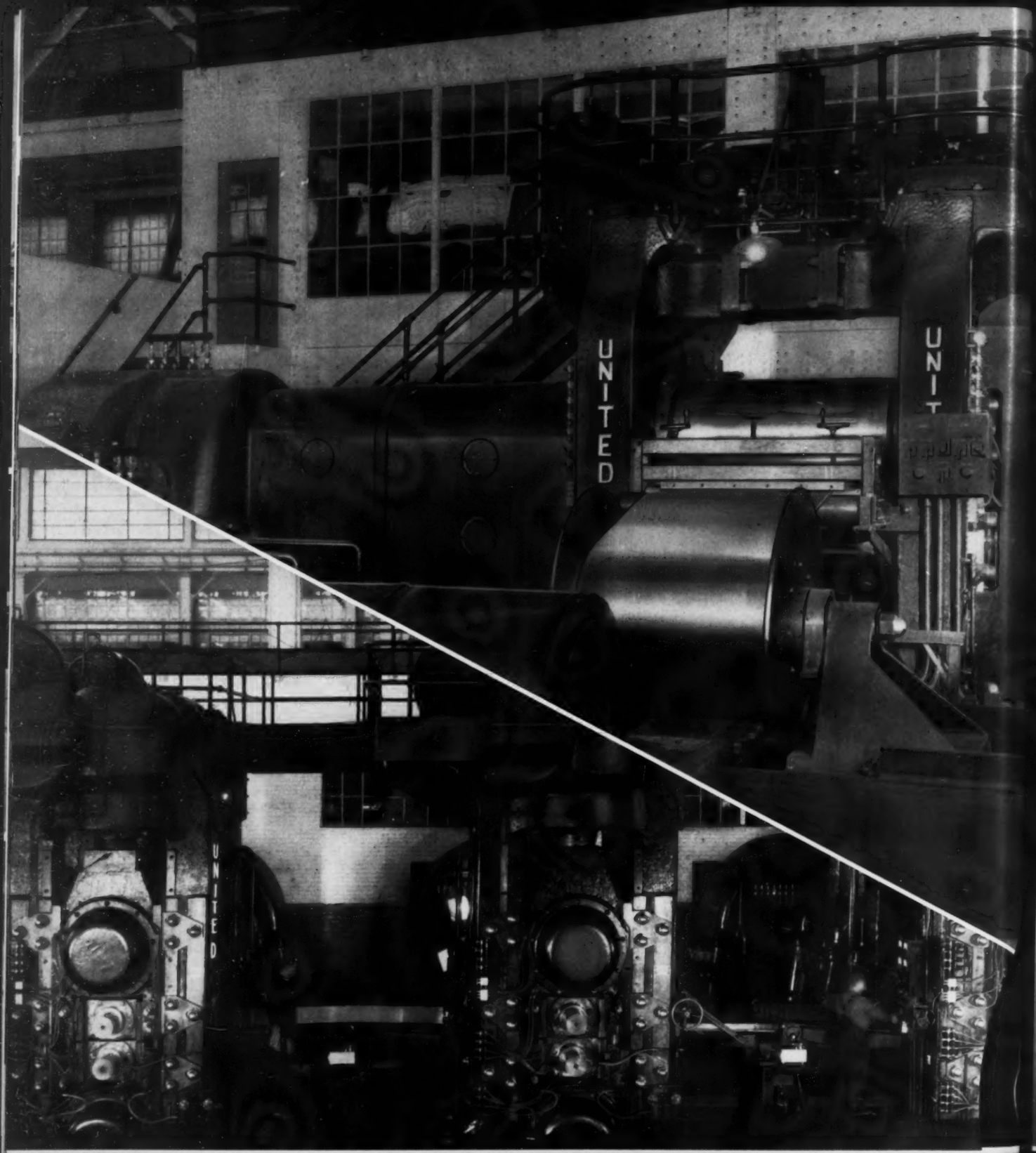


IN U·S·A·

The Ford installation consists of:

44" Reversing Blooming Mill and Slab Shear
56" Continuous Hot Strip Mill consisting of:
1 24"x56" Roughing Scale Breaker
1 42"x96" Broadside Mill
1 32"x56" Rougher and Edger
2 21"&46"x56" 4-High Roughers and Edgers
1 24"x56" Finishing Scale Breaker
5 21"&46"x56" 4-High Finishing Stands
2 Down Coilers
1 Flying Shear and Piler

IN RUSSIA



IN ENGLAND

U

3 Stand 18" &49" x56" Tandem Cold Reduction Mill, with Uncoiler, Sticker and Tension Reel

20½"&56"x84" Reversing Cold Reduction Mill with Tension Reels on both sides

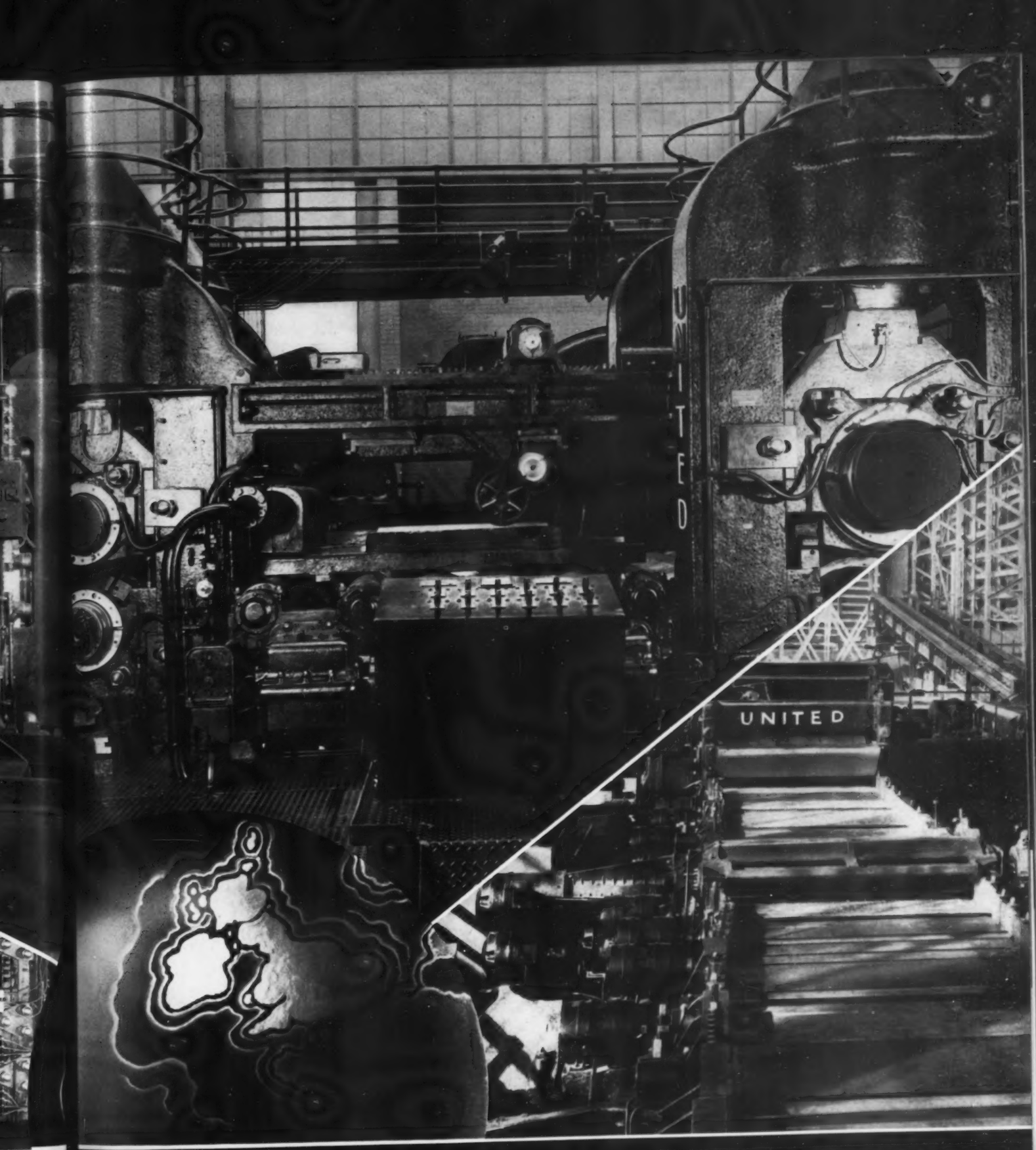
2 27"x56" 2 High Temper Pass Mills with Uncoilers and Tension Reels

Upcut Flying Shear Line after No. 1 pickler

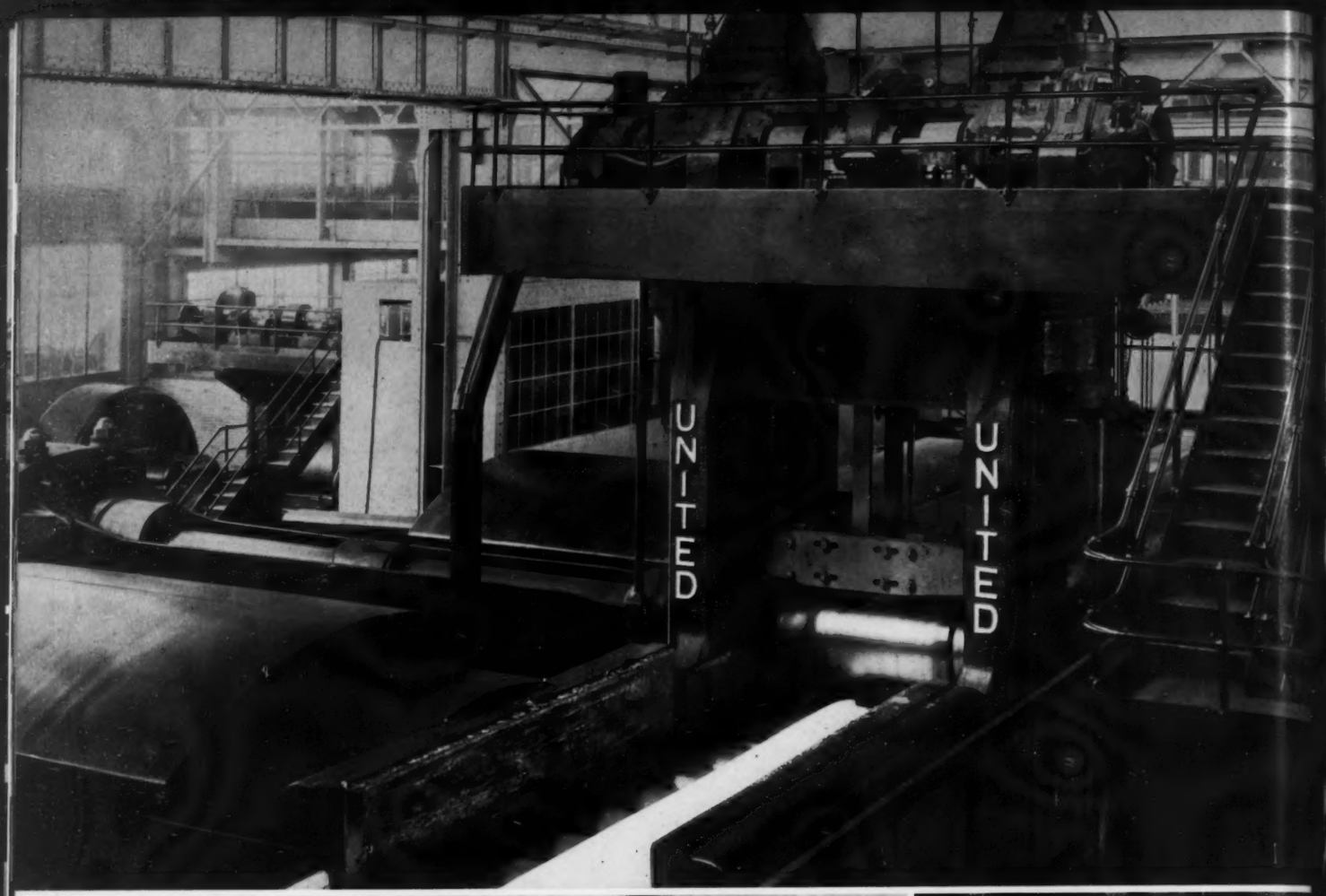
Strip Welding Line for Coils

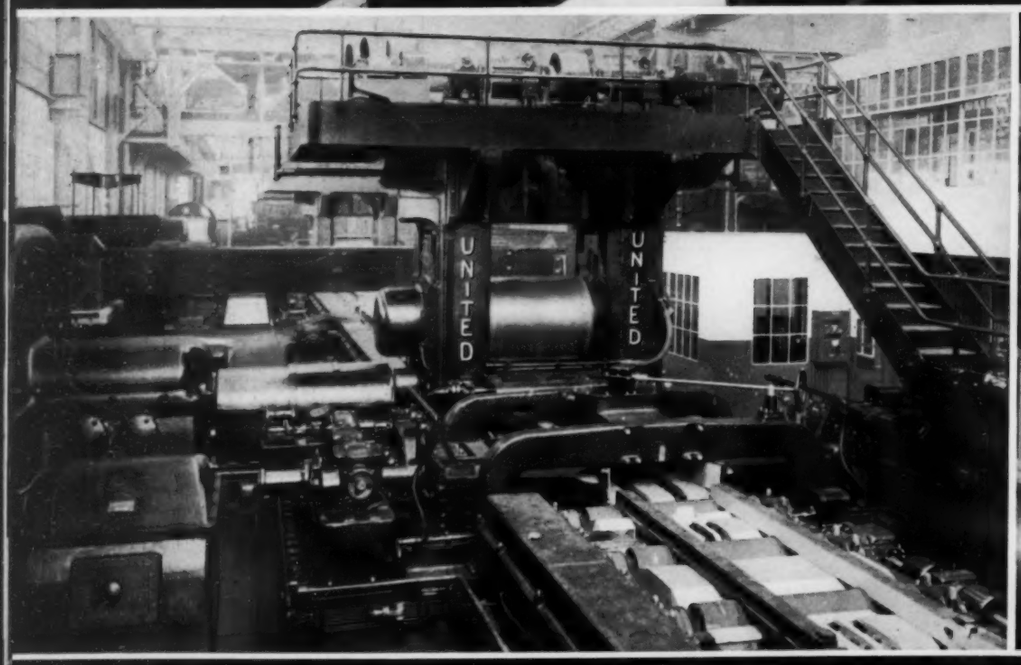
Cold Flying Shear Line consisting of Uncoiler, Side Trimmer, Flying Shear, Leveller and Piler

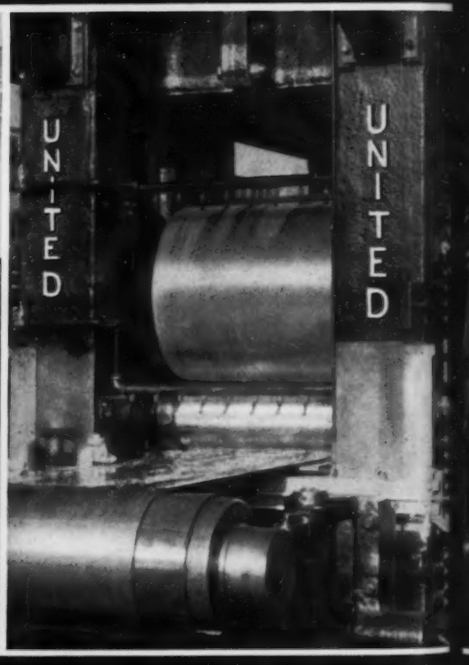
Complete mechanical equipment for Normalizing Line



UNITED • COMPLETE

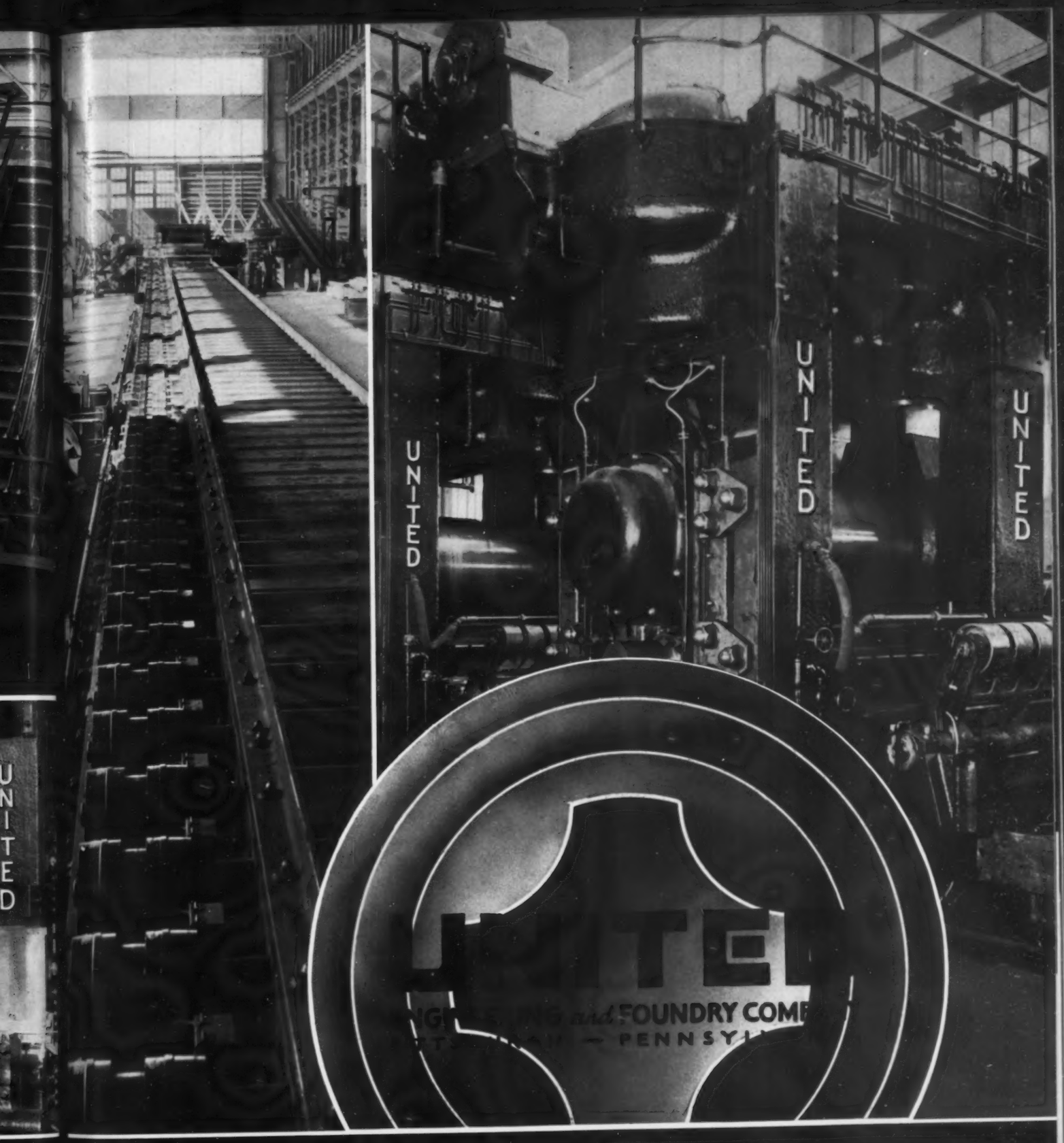






ROLLING MILLE

The United Engineering & Foundry Company served as consulting engineers as well as designers and builders of all three installations.

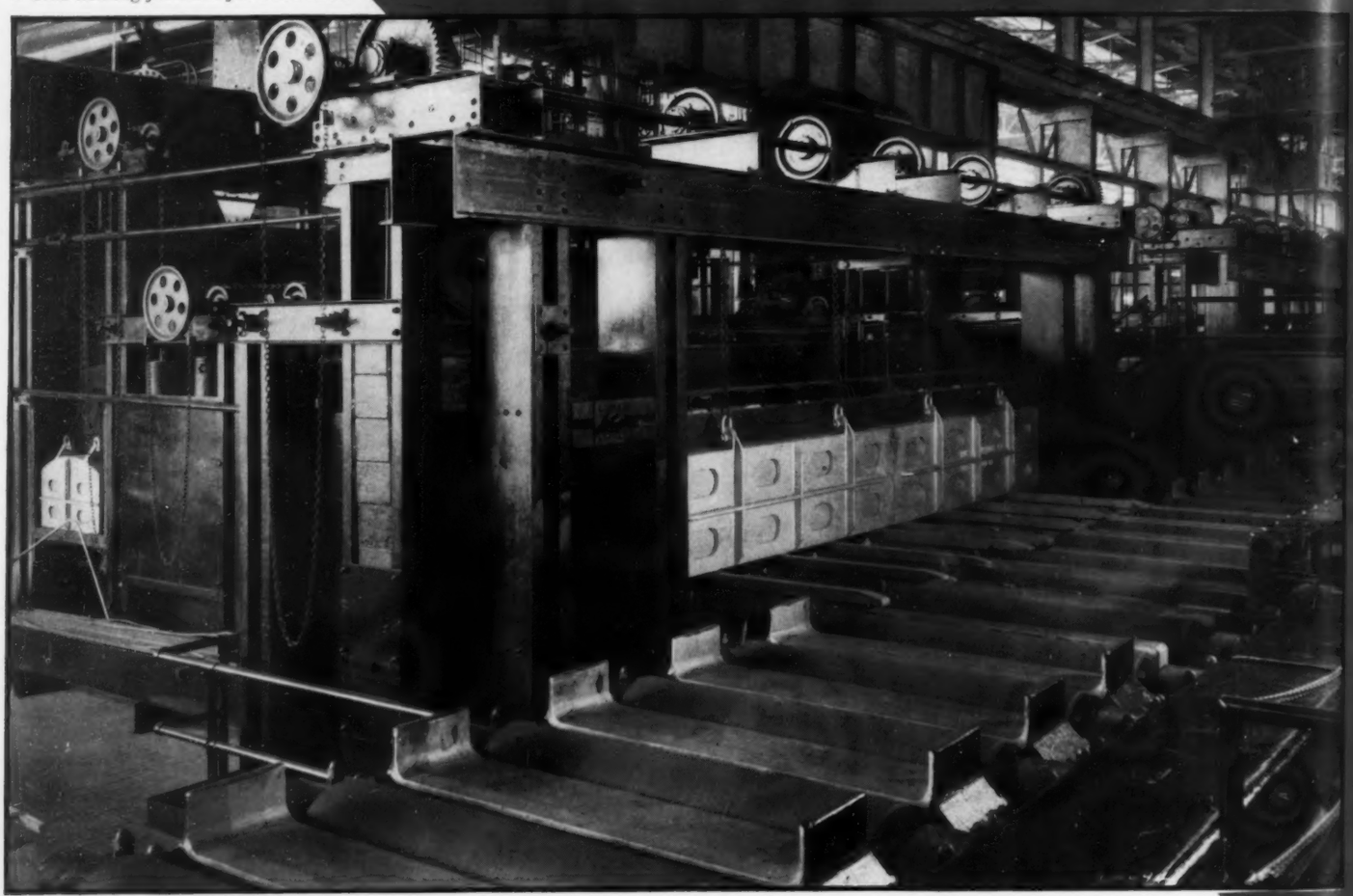


L E Q U I P M E N T ★

undry
engi-
ilders

CARBORUNDUM CO A
SERVES FORD T
IN NEW CONTINU S

● *Slab heating furnaces for Ford Mill.*

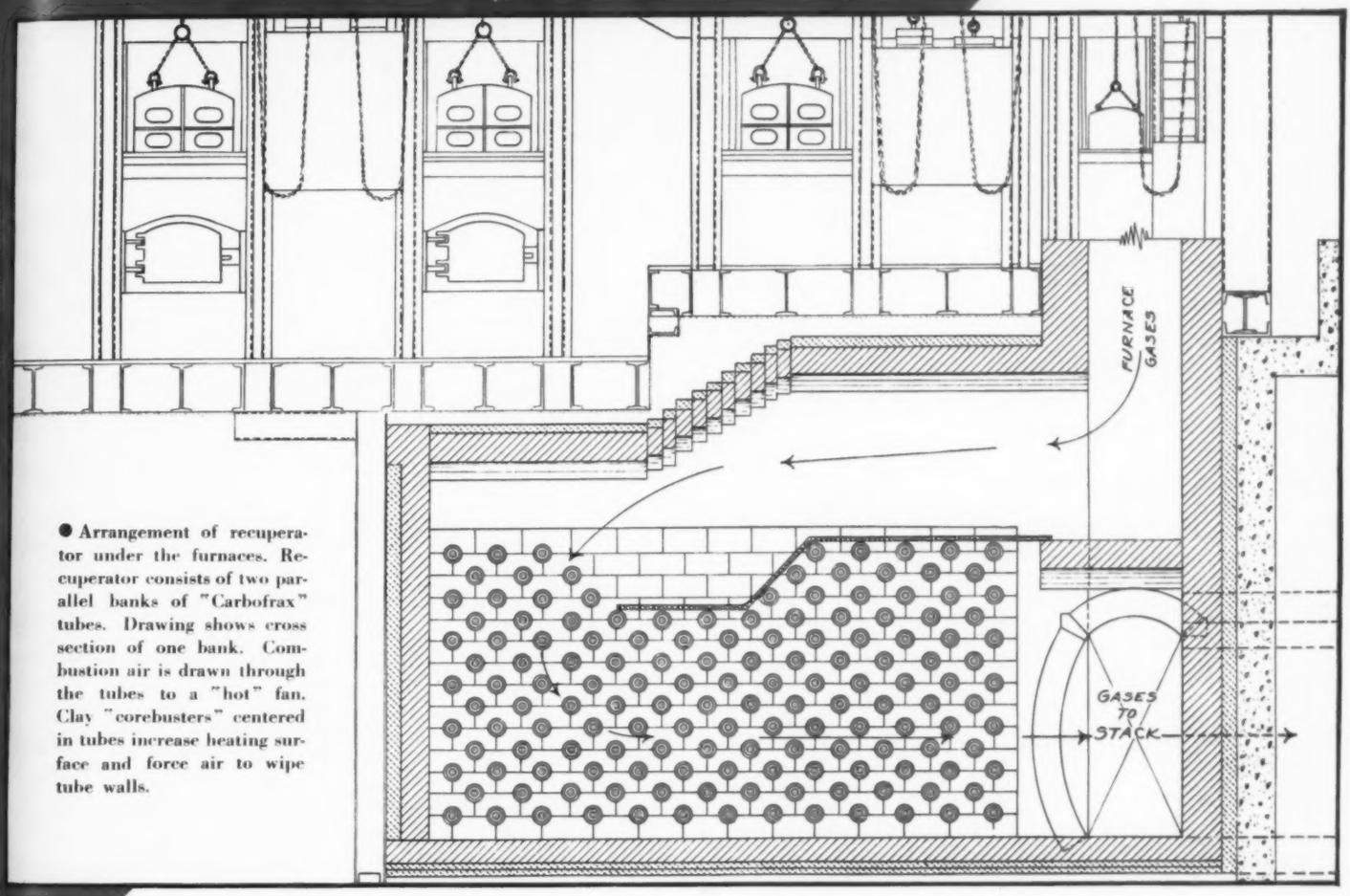


THE installation of a CARBORUNDUM COMPANY RECUPERATOR in the Ford Motor Company's new mill is further proof of the wide acceptance of this equipment by engineers of the Steel Industry. Three million five hundred thousand tons of steel is the annual capacity of the slab and billet heating furnaces which have been equipped with this recuperator within the past two and one-half years.

The Carborundum Company Recuperator is flexible in design, requires a minimum of space,

THE CARBORUNDUM COMPANY T

ANY RECUPERATOR
TOR COMPANY
S HOT STRIP MILL



● Arrangement of recuperator under the furnaces. Recuperator consists of two parallel banks of "Carbofrax" tubes. Drawing shows cross section of one bank. Combustion air is drawn through the tubes to a "hot" fan. Clay "corebusters" centered in tubes increase heating surface and force air to wipe tube walls.

and can be installed at low first cost. It provides uniform air temperature, minimum air leakage and high heat transfer. This results in efficient operation and fast pick up. Unusual accessibility and durability assure low maintenance charges and the elimination of shutdowns. Our engineers will be glad to call for a complete discussion.

THE CARBORUNDUM COMPANY, REFRACTORY DIVISION, PERTH AMBOY, N. J.

REG. U. S. PAT. OFF.

(Carborundum is a registered trade-mark of The Carborundum Company.)

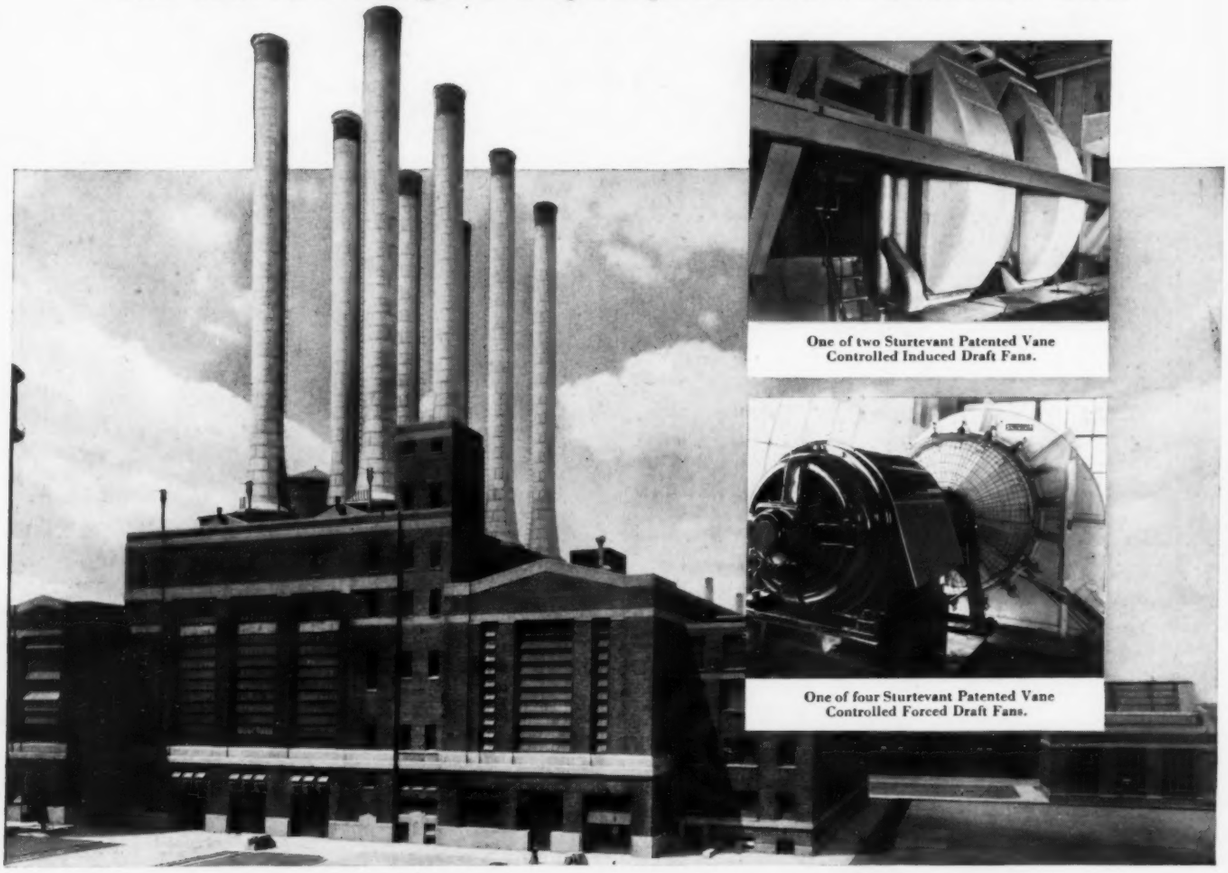
Y THE CARBORUNDUM COMPANY

RATED:

For FORD'S *New Boiler*

900,000 LBS. OF STEAM PER HOUR!

Sturtevant Mechanical Draft Fans Selected for World's Largest Super-pressure Industrial Unit



One of two Sturtevant Patented Vane Controlled Induced Draft Fans.

One of four Sturtevant Patented Vane Controlled Forced Draft Fans.

FAN TIP SPEEDS OF 3½ AND 4 MILES PER MINUTE!

Very high pressures . . . 12" and 18" . . . must be developed by these six Sturtevant Patented Vane Controlled Mechanical Draft Fans at Ford's River Rouge plant. They are operated at terrific tip speeds . . . over 3½ and 4 miles per minute! They've got to be extremely flexible, rugged and reliable to furnish the draft for burning all of four fuels . . . powdered coal, blast furnace gas, coke oven gas, or atomized tar.

Sturtevant Patented Vane Controlled Fans were selected for these conditions because they combine the flexibility and immediate response of dampers with the efficiency of variable speed control.

	Induced Draft	*Forced Draft*
Total weight of Fans	70,000 pounds	6,500 pounds
Volume	260,000 C. F. M.	70,000 C. F. M.
Static Pressure	18 inches	12 inches
Tip Speed	21,200 ft. per min.	19,000 ft. per min.
R. P. M.	870	1,750

Boiler: "Combustion Engineering Company, Inc." Evaporates 900,000 lbs. of steam per hour at 1400 lbs. pressure and 900°F.

B. F. STURTEVANT COMPANY, Hyde Park, Boston, Mass.
Branches in 40 Cities B. F. Sturtevant Co. of Canada, Ltd.—Galt, Toronto, Montreal

Sturtevant
REG. U. S. PAT. OFF.

Puts Air to Work

DRAFT FANS · TURBINES · GEARS · ECONOMIZERS · AIR HEATERS

TRADE **AUTOMATIC** MARK

COIL HANDLING TRACTORS

A CAPABLE MODERN SYSTEM FOR CONTINUOUS STRIP MILLS

IN SERVICE AT THE

FORD MOTOR COMPANY

SEE THESE "AUTOMATICS" AT THE IRON and STEEL EXPOSITION DETROIT

SEPT. 22 TO 25 INCLUSIVE
BOOTHS 148 — 149 — 150

★ With THE NEW CONTINUOUS PROCESS for the production of STRIP STEEL, the capable handling and co-ordinated transportation of heavy strip steel coils from one process to another is a major task and is of VITAL IMPORTANCE for scheduled CONTINUOUS PRODUCTION.

TO-DAY 24 HOURS EACH DAY—"AUTOMATIC" HEAVY DUTY COIL HANDLING TRACTORS are continually operating many miles in performing this task for various large strip mills. They are transporting SAFELY — EFFICIENTLY — AT LOWEST COST heavy strip steel coils as you see above weighing 7,000 to 30,000 lbs. From picklers to cold rolls —To storage —To weighing scales —To rotary shears.

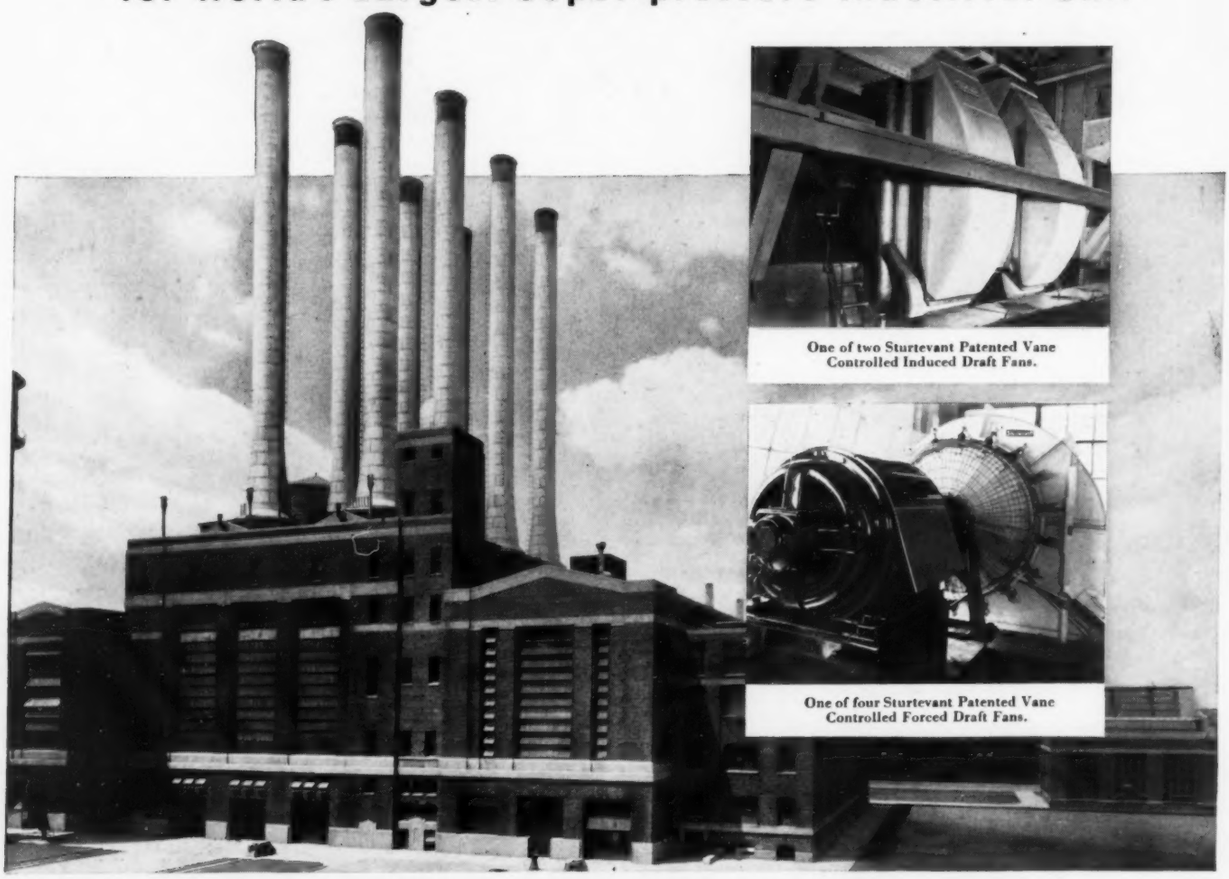
AUTOMATIC TRANSPORTATION COMPANY
DIVISION OF YALE & TOWNE MANUFACTURING CO.
47 WEST 87TH STREET CHICAGO, ILLINOIS

IONEER MANUFACTURERS OF POWER TRUCKS - TRACTORS & CRANES

RATED: *For* **FORD'S** *New Boiler*

900,000 LBS. OF STEAM PER HOUR!

Sturtevant Mechanical Draft Fans Selected for World's Largest Super-pressure Industrial Unit



One of two Sturtevant Patented Vane Controlled Induced Draft Fans.

One of four Sturtevant Patented Vane Controlled Forced Draft Fans.

FAN TIP SPEEDS OF 3½ AND 4 MILES PER MINUTE!

Very high pressures . . . 12" and 18" . . . must be developed by these six Sturtevant Patented Vane Controlled Mechanical Draft Fans at Ford's River Rouge plant. They are operated at terrific tip speeds . . . over 3½ and 4 miles per minute! They've got to be extremely flexible, rugged and reliable to furnish the draft for burning all of four fuels . . . powdered coal, blast furnace gas, coke oven gas, or atomized tar.

Sturtevant Patented Vane Controlled Fans were selected for these conditions because they combine the flexibility and immediate response of dampers with the efficiency of variable speed control.

	Induced Draft	*Forced Draft*
Total weight of Fans	70,000 pounds	6,500 pounds
Volume	260,000 C. F. M.	70,000 C. F. M.
Static Pressure	18 inches	12 inches
Tip Speed	21,200 ft. per min.	19,000 ft. per min.
R. P. M.	870	1,750

Boiler: "Combustion Engineering Company, Inc." Evaporates 900,000 lbs. of steam per hour at 1400 lbs. pressure and 900°F.

B. F. STURTEVANT COMPANY, Hyde Park, Boston, Mass.
Branches in 40 Cities B. F. Sturtevant Co. of Canada, Ltd.—Galt, Toronto, Montreal

Sturtevant
REG. U. S. PAT. OFF.
Puts Air to Work

DRAFT FANS · TURBINES · GEARS · ECONOMIZERS · AIR HEATERS

TRADE **AUTOMATIC** MARK

COIL HANDLING TRACTORS

IN SERVICE AT THE

FORD MOTOR COMPANY

SEE THESE "AUTOMATICS" AT THE IRON and STEEL EXPOSITION DETROIT

SEPT. 22 TO 25 INCLUSIVE
BOOTHS 148 — 149 — 150

★ With THE NEW CONTINUOUS PROCESS for the production of STRIP STEEL, the capable handling and co-ordinated transportation of heavy strip steel coils from one process to another is a major task and is of VITAL IMPORTANCE for scheduled CONTINUOUS PRODUCTION.

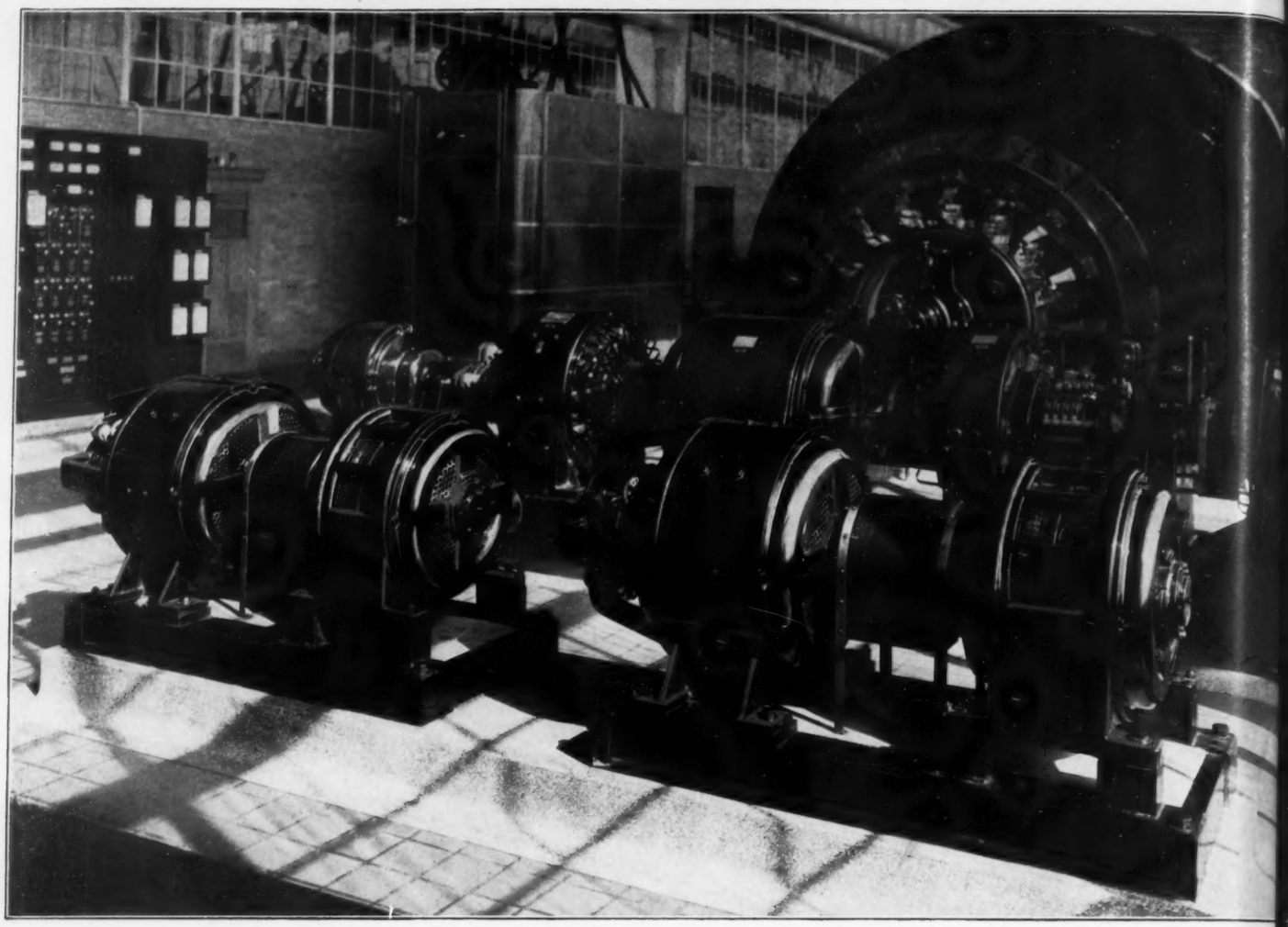
TO-DAY 24 HOURS EACH DAY—"AUTOMATIC" HEAVY DUTY COIL HANDLING TRACTORS are continually operating many miles in performing this task for various large strip mills. They are transporting SAFELY — EFFICIENTLY — AT LOWEST COST heavy strip steel coils as you see above weighing 7,000 to 30,000 lbs. From picklers to cold rolls —To storage —To weighing scales —To rotary shears.

AUTOMATIC TRANSPORTATION COMPANY

DIVISION OF YALE & TOWNE MANUFACTURING CO.

47 WEST 87TH STREET CHICAGO, ILLINOIS

IONEER MANUFACTURERS OF POWER TRUCKS - TRACTORS & CRANES



A Vital Detail In the Operation of This Mill

We shall be glad to send you a copy of our Bulletin 96, describing the design and operating characteristics of the Diverter Pole generator.

The Electric Products Co.

CLEVELAND, OHIO

SINCE 1920, the year in which the Rouge Plant of the Ford Motor Company was placed in operation, progress in the design and construction of steam-generating units has gone forward at an amazing pace. The maximums of established practice today, with respect to steam pressures and temperatures, economy of steam production, and sizes and capacities of steam-generating units, represent revolutionary changes as compared to 1920 practice.

The Rouge Plant, perhaps to a greater extent than any other steam plant in the world, exemplifies the progress of this period.

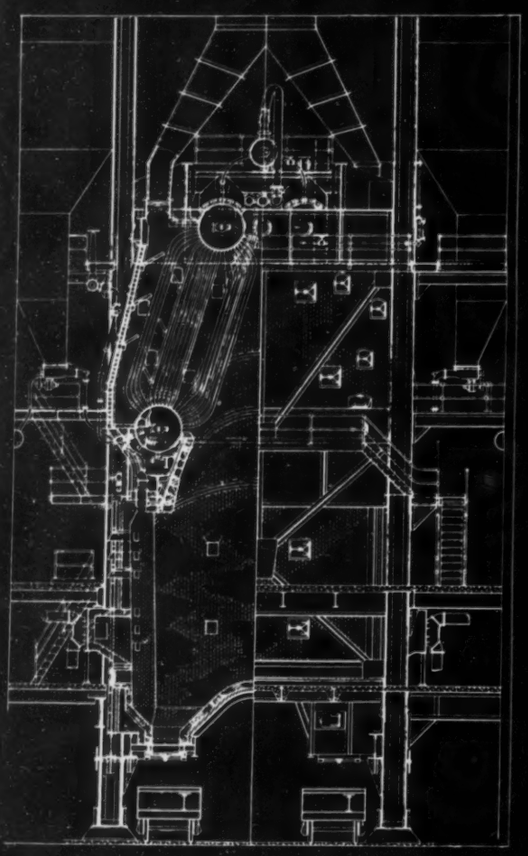
Combustion Engineering is particularly proud of its identification with this great plant from the time it was built through every stage of its modernization to date.

The story of the growth and modernization of the Rouge Boiler Plant is briefly told in the following pages.

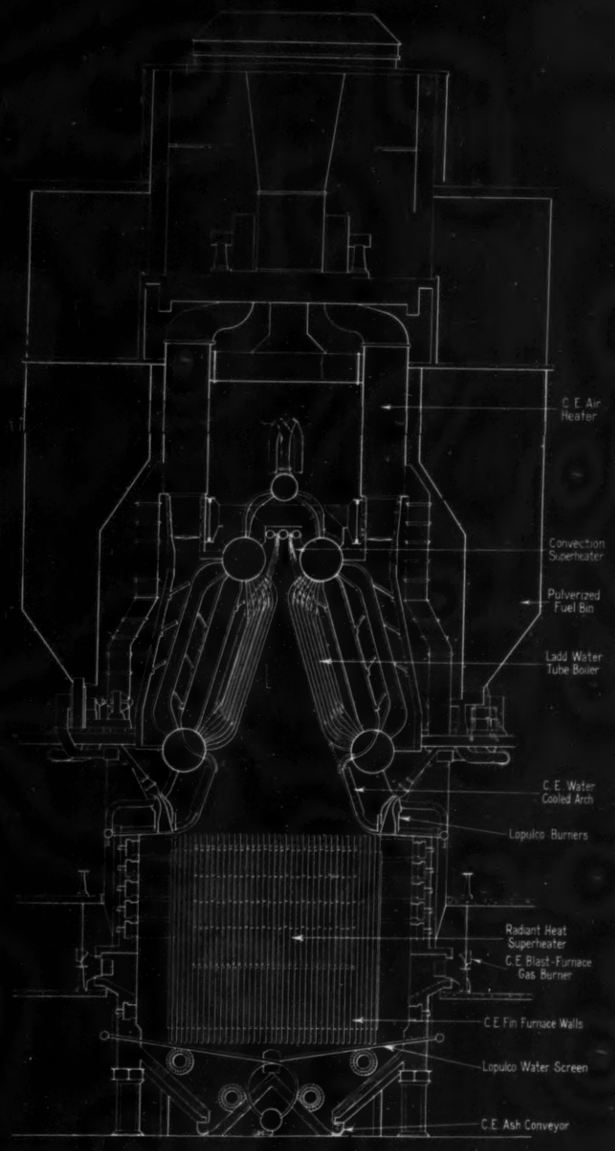
C-E

COMBUSTION ENGINEERING

200,000 LB.



500,000 LB.



1920 — The Rouge Plant went into operation with the boiler unit shown above, one of four such units comprising the original installation. These boilers, with 26,470 sq ft of heating surface each, were the largest in the world at the time. In 1923 four additional boiler units, duplicates of the above, were installed. These eight units completely occupied the floor space available for boilers in the plant. They had a maximum continuous capacity of about 200,000 lb of steam per hr each at 240 lb pressure and about 600 F total temperature. The boilers were of the Ladd type with Elesco Superheaters and were fired by pulverized coal either singly or in combination with blast furnace gas. Pulverized coal systems comprising mills, feeders, burners and related equipment were supplied by Combustion Engineering.

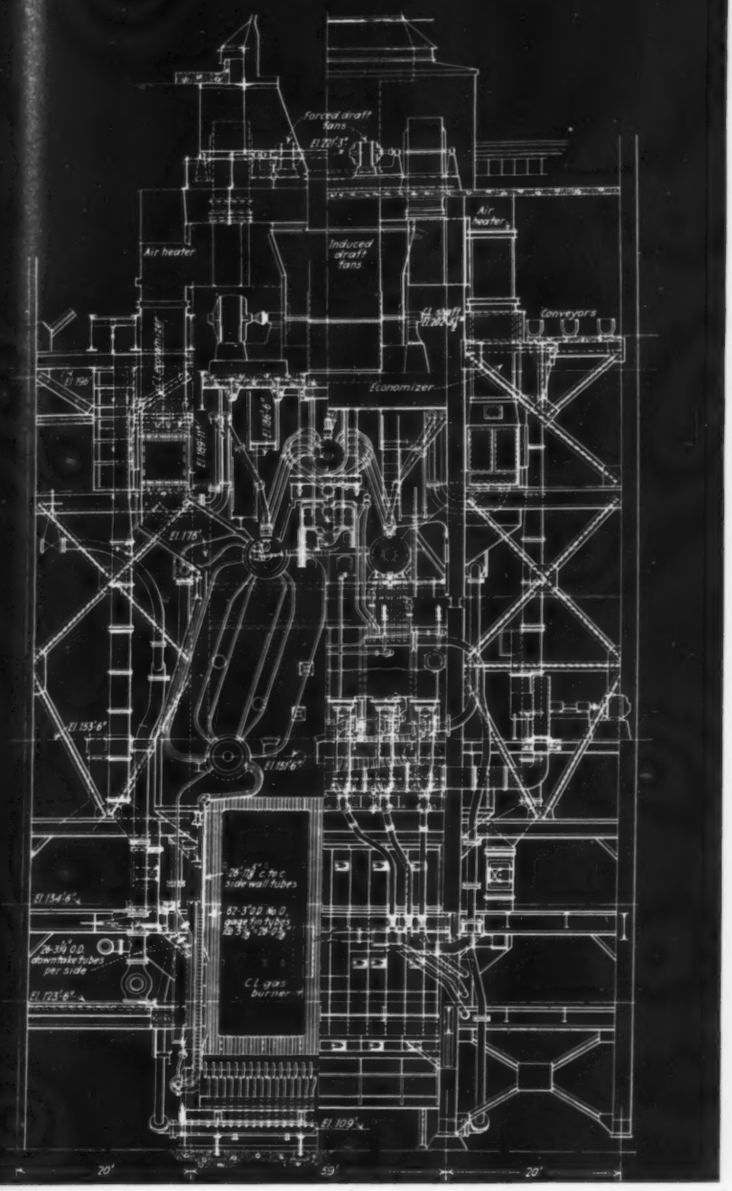
1925 — More steam was needed and Combustion Engineering began the work of remodeling one of the original boiler units to produce 500,000 lb of steam per hr. Water-cooled walls, radiant superheaters and additional burners were installed in the furnace. Two plate-type air preheaters were installed and additional fan capacity provided. The remodeled unit operated so successfully that in 1926 it was decided to meet the still growing steam demand by remodeling three more boilers. Thus four of the original units became capable of producing more than twice their previous capacity, although still occupying the same amount of floor space. Large economies resulted due to the low fixed charges on the additional capacity and also to the higher efficiency and reduced maintenance costs of the remodeled units.

19

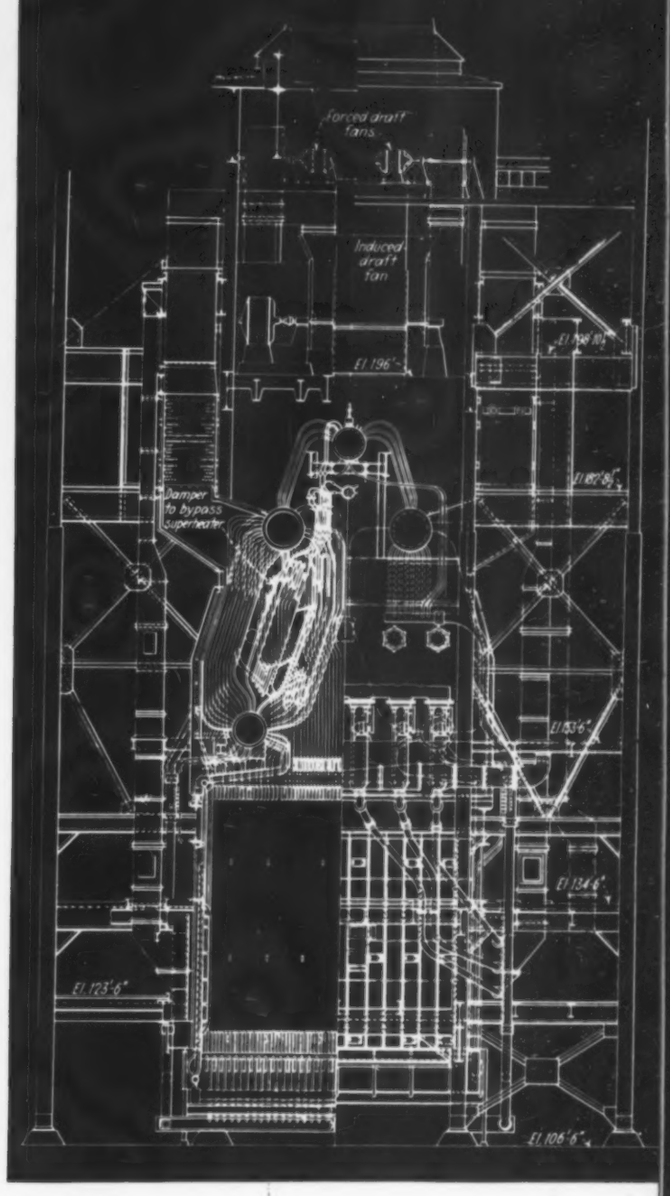
than fu
Carefu
two of
bustion
units a
of this
largest
were d
at 140
pacities
econon
equipm

COMBUSTION

700,000 LB.



900,000 LB.



1929 — Again Ford operations were taxing the capacity of the Rouge Plant, but progress by this time permitted of a better solution than further remodeling of the remaining four original units. Careful study of the problem led to the decision to replace two of the old boilers with modern high-pressure units. Combustion Engineering received the complete contract for these units and installation began in 1930. With the completion of this installation in 1931, the Rouge Plant contained the largest super-pressure boilers in the world. The new units were designed to produce up to 700,000 lb of steam per hr at 1400 lb pressure and 750 F total temperature. Peak capacities obtained have exceeded the design figure. Boilers, economizers, air preheaters, furnaces and pulverized fuel equipment are all of CE design and manufacture.

1935 — Records fall again as installation of a steam-generating unit, designed to produce up to 900,000 lb of steam per hr at 1400 lb pressure and 925 F total temperature, nears completion at the Rouge Plant. This unit, by a substantial margin the highest capacity super-pressure unit in the world, replaces one of the two remaining original units. It occupies the same area allotted to that unit, but is capable of producing more than four times its maximum capacity. Like its predecessors, this great unit is comprised of a CE Boiler with Elesco Superheaters and Economizers, CE Air Heaters, Water-Cooled Furnace and Pulverized Fuel Equipment. With this unit placed in service in the summer of 1936, a new chapter has been added to the epic story of Rouge —the largest industrial steam power plant in the world.

ENGINEERING

C-E BOILER PLANT EQUIPMENT

CE PRODUCTS

BOILERS
Sectional Header
Box Header
(two types)
Bent Tube
(four types)
Fire Tube
(four types)
Marine
(all standard types)
Electric
(Included in above list are all types known by the tradenames Heine, Walsh-Weidner, Casey-Hedges *and* Ladd*)*

STOKERS
Multiple-Retort Underfeed
Single-Retort Underfeed
(five types)
Traveling Grate
(two types)
Chain Grate
(three types)
(Included in above list are all types known by the tradenames Coxe, Green, Type E, Type K *and* Skelly*)*

PULVERIZED FUEL SYSTEMS
(for boilers and industrial furnaces)
Storage
Direct Fired
(CE Pulverized Fuel Systems, formerly known as Lopulco, *include* Raymond *Pulverizers)*

FURNACES
Dry Bottom
Slagging
Water-Cooled Walls and Screens

COMPLETE UNITS
Two standard designs, one for large plants and the other for medium-sized and smaller plants

Coordinated designs comprising any combination of boiler and firing equipment

ALLIED EQUIPMENT
Air Heaters
(Regenerative, Plate and Tubular Types)
Economizers
Oil Burners
Ash Conveyors
Ash Hoppers

PULP MILL EQUIPMENT
CE Murray-Waern System
(for chemical and waste heat recovery)

DRYING AND INCINERATION
CE-Raymond System
(for sewage sludge incineration)
CE-Raymond Flash Drying Systems

FABRICATED PRODUCTS
Pressure Vessels, Tanks, Towers, etc.
(welded or riveted fabrication —carbon, alloy or clad steel)

ASSURES MINIMUM STEAM COSTS

Combustion Engineering's line of boiler plant equipment is complete for plants ranging from those requiring boilers of 50 hp or less up to the largest power stations.

CE equipment and experience will assure the right solution of your steam-production problem whether it involves a new plant or modernization or extension of an existing plant — the right solution in terms of minimum steam cost and a thoroughly satisfactory installation.

NOTABLE CE INSTALLATIONS

Highest capacity boilers*
Three CE Multi-Drum Boilers at East River Station, New York Edison Co. Have operated at rate of 1,270,000 lb of steam per hr per unit.

Highest capacity super-pressure boiler*
CE Multi-Drum Boiler at Rouge Plant, Ford Motor Co. 900,000 lb per hr—1400 lb pressure—925 F steam temperature. The Rouge Plant is the largest industrial power plant in the word. Its eight steam-generating units are comprised of CE equipment throughout.

Highest pressure boilers in commercial operation in America*
Two CE special design boilers at Lockland, Ohio, plant, Philip Carey Co. Pressure—1800 lb.

Highest capacity stoker-fired boilers
Eight CE Multi-Drum Boilers at Hudson Ave. Station, Brooklyn Edison Co. Capacity per boiler—530,000 lb per hr. Hudson Ave. is the world's largest power station.

Highest capacity single sectional header boiler*
CE Sectional Header Boiler at Burlington Station, Public Service Electric & Gas Co. of N. J. Has operated at rate of 625,000 lb per hr.

Boiler holding the world's record for sustained output*
CE Multi-Drum Boiler at Kips Bay Station, New York Steam Corp. Has averaged 805,000 lb per hr for a month. The five steam-generating units in Kips Bay, the largest central heating plant in the world, are comprised of CE equipment.

Largest single-pass sectional header boiler*
CE Sectional Header Boiler at Duluth Station, Minnesota Power & Light Co. Boiler is 40 tubes high by 38 tubes wide and has 36,550 sq ft of heating surface.

Highest pressure boiler having welded drums*
CE Sectional Header Boiler at Akron Plant, Firestone Tire & Rubber Co. Pressure—1400 lb. Drum with 4¼ in. shell fusion welded at CE shops.

Highest capacity 3-drum bent tube boiler*
CE Boiler at Port Washington Station, The Milwaukee Elec. Rwy. & Lt. Co. Capacity 690,000 lb per hr. Pressure—1390 lb. The complete CE Steam-Generating Unit of which this boiler is a part is the sole source of steam supply for an 80,000 kw turbine-generator.

*Units comprised of CE equipment throughout.

COMBUSTION ENGINEERING COMPANY - INC

200 MADISON AVENUE, NEW YORK - OFFICES IN PRINCIPAL CITIES

Canadian Associates: Combustion Engineering Corp., Ltd., Montreal

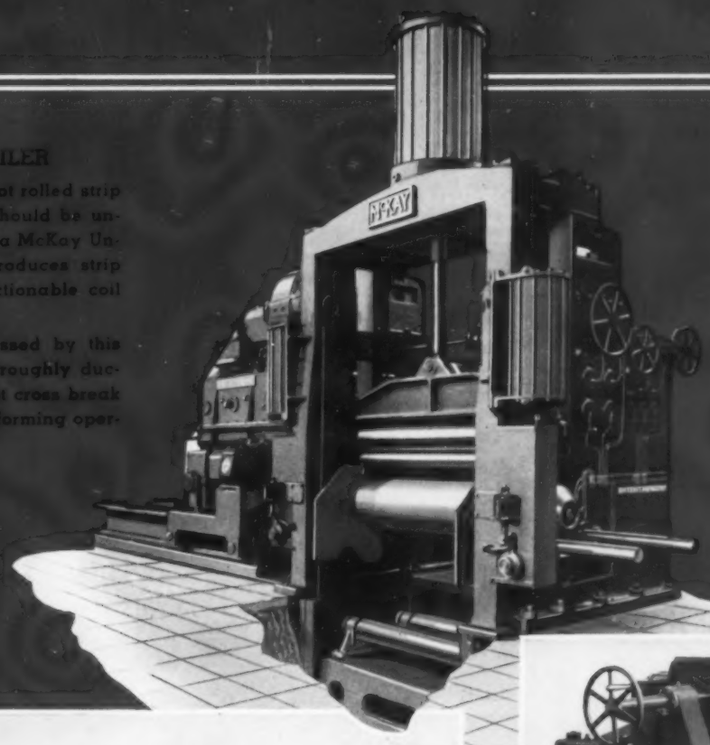
COMBUSTION ENGINEERING

McKAY EQUIPMENT FOR THE SHEET AND STRIP INDUSTRY

UNCOILER

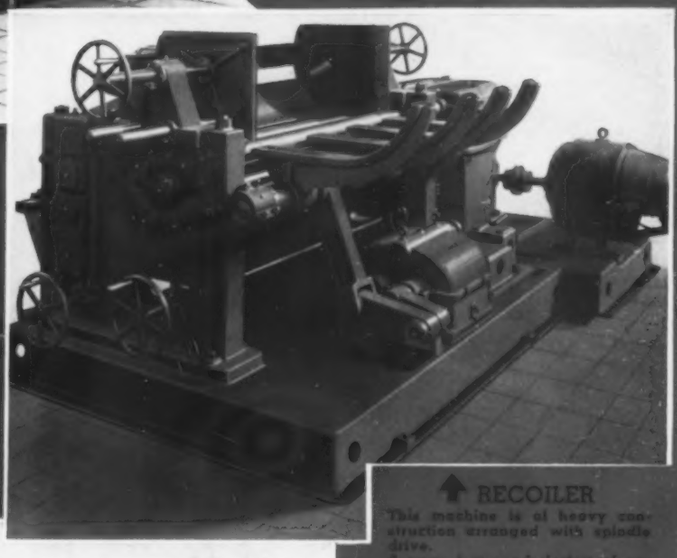
The first time hot rolled strip is uncoiled it should be uncoiled through a McKay Uncoiler. This produces strip free from objectionable coil breaks.

Material processed by this machine is thoroughly ductile and will not cross break in subsequent forming operations.



OUR PRODUCTS

BUDD-McKAY SHEET PROCESSING MACHINES.
TWO AND FOUR HI LEVELLERS.
SCRUBBING MACHINES.
OILING MACHINES.
STRIP UNCOILERS.
STRIP RECOILERS.
SCRAP BUNDLERS.
UP-CUT SHEARS.
CONVEYOR TABLES.
ROTARY SLITTERS.
SHEET DRYERS.
TOOL STEEL ROLLS.
COLD ROLL FORMING MACHINES.



⬆ RECOILER

This machine is of heavy construction arranged with spindle drive.

A new, improved design of mandrel and side guides produces an exceptional tight and uniform coil. All adjustments have been arranged so that they are readily accessible to the operator, both for setting of sizes of coil, and position of side guide, which may be done very quickly and with a minimum of effort. Machine may also be equipped with an oiling system as required.

⬆ SHEET PROCESSOR

With the new Budd-McKay Sheet Processor machine it is possible to render sheets free from stretcher strains. Sheets processed on this new patented processing machine have far superior stamping and drawing qualities, and retain these qualities much longer, than sheets leveled by the ordinary roller levelling method.

⬅ UP-CUT SHEAR

This machine characterized by its heavy and rugged design is in use by various steel mills for continuous strip pickling and processing lines.

The drive is arranged to start and stop for each cut, thus eliminating clutches with their attendant difficulties.

It can be furnished with or without pinch rolls as desired.

THE McKAY MACHINE COMPANY

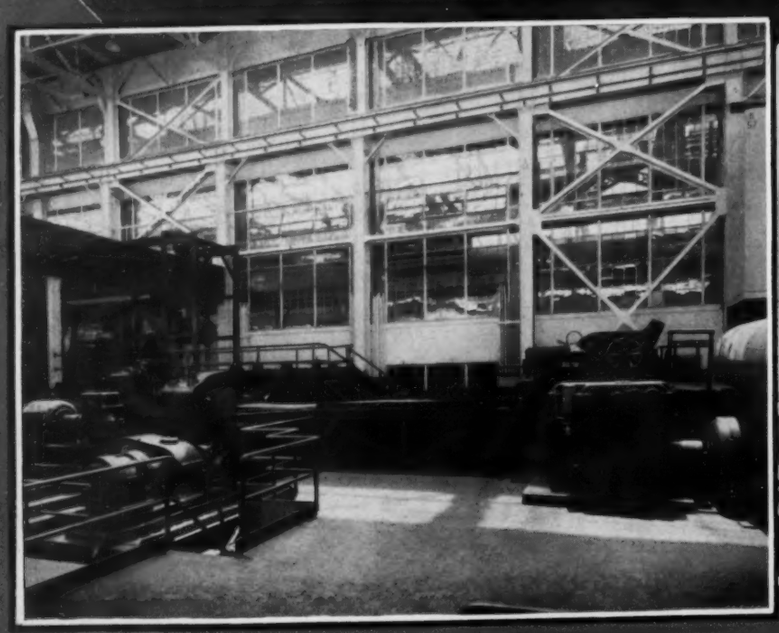
ENGINEERS AND MANUFACTURERS OF SHEET, TIN AND STRIP MILL EQUIPMENT

YOUNGSTOWN, OHIO

ASSOCIATED COMPANY

THE WEAN ENGINEERING CO., Inc. • Warren, Ohio

The World's Largest Automobile Plant us

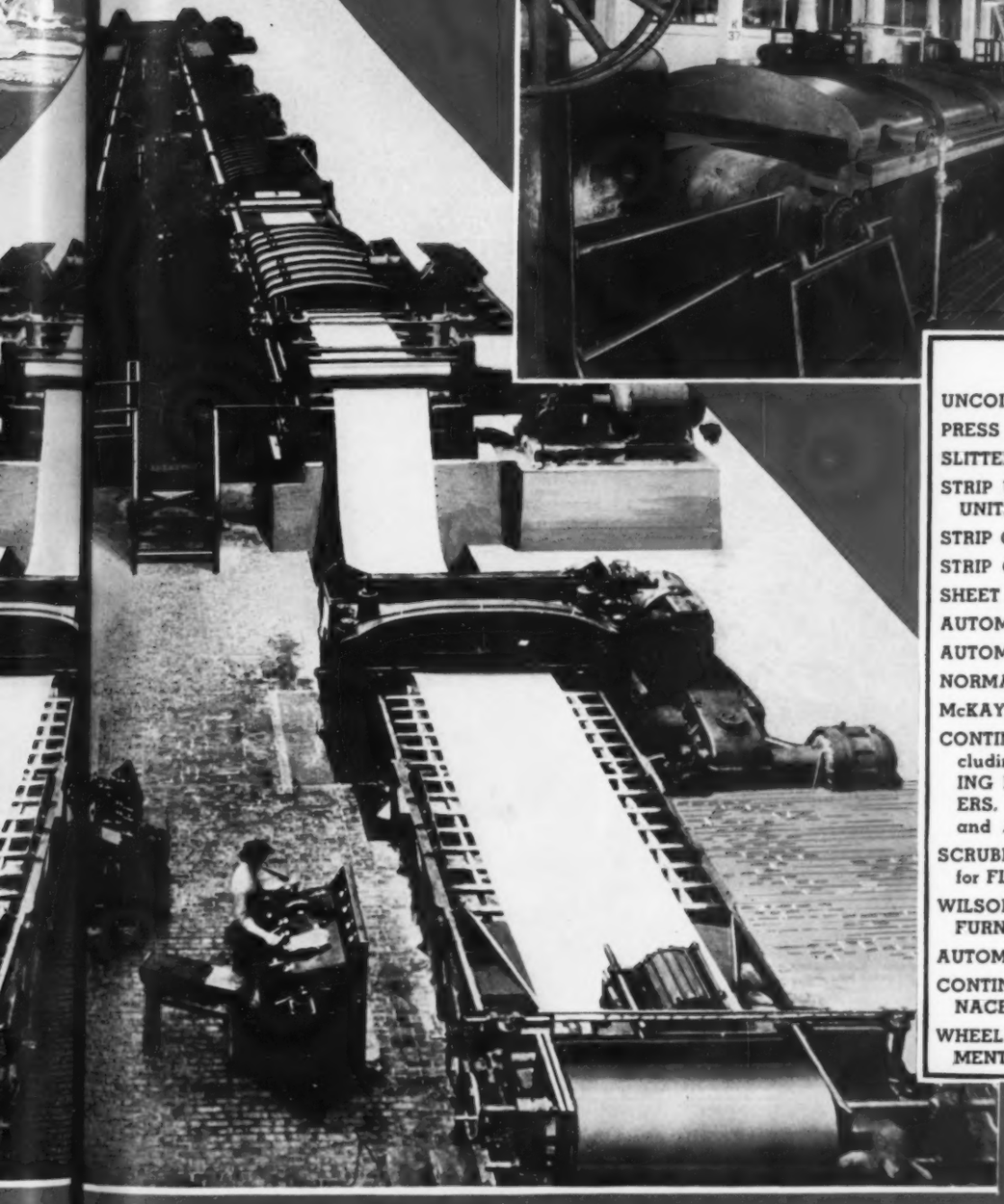


Shear for cutting out stitch and strip coiling in our installation at the Ford Motor Car Company's plant.

The Wean Engineering Com

THE WEAN CONTINUOUS STRIP PICKLING UNIT

aving pinch rolls and entering first acid
our Continuous Strip Pickling unit instal-
t the Ford Motor Car Company's plant.



Completely engineered and installed by the Wean Engineering Company, Inc., Warren, Ohio.

OUR PRODUCTS

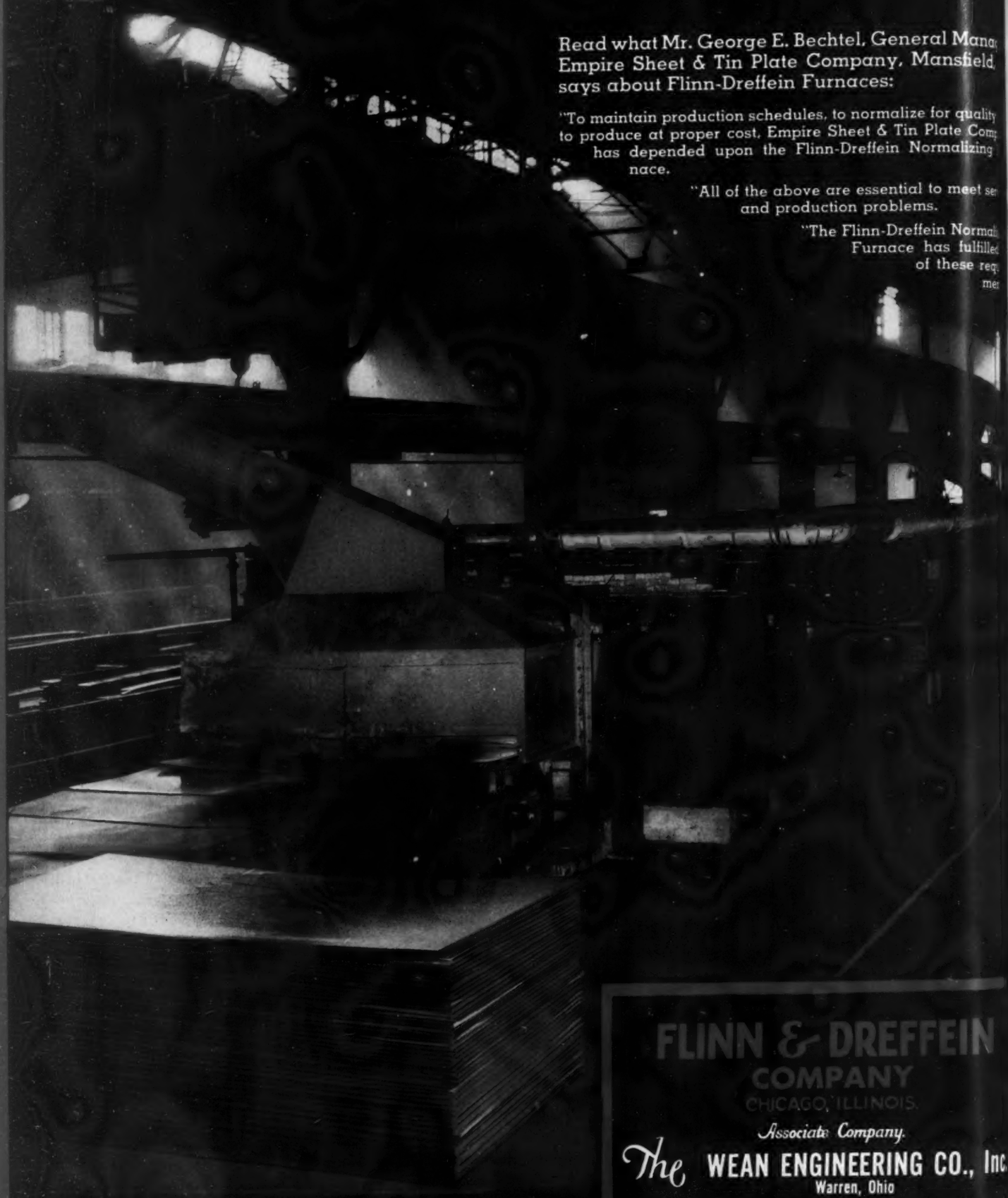
- UNCOILING UNITS.
- PRESS FEEDING EQUIPMENT.
- SLITTERS.
- STRIP UNCOILING AND AUTOMATIC SHEARING UNITS.
- STRIP COIL HOLDERS.
- STRIP COILING REELS.
- SHEET GALVANIZING EQUIPMENT
- AUTOMATIC TINNING EQUIPMENT.
- AUTOMATIC DOUBLERS.
- NORMALIZING FURNACES.
- McKAY LEVELLERS AND PROCESSING UNITS.
- CONTINUOUS STRIP PICKLING EQUIPMENT including: UNCOILERS, UP-CUT SHEARS, STITCHING MACHINES, PINCH ROLL UNITS, RECOILERS, DRYING MACHINES, PICKLING TANKS, and AUXILIARY EQUIPMENT.
- SCRUBBING, LEVELING, and OILING MACHINES for FLAT PRODUCTS.
- WILSON VERTICAL TUBE TYPE ANNEALING FURNACES.
- AUTOMATIC FEEDING AND CATCHING TABLES.
- CONTINUOUS PACK AND PAIR HEATING FURNACES.
- WHEELABRATOR ABRASIVE CLEANING EQUIPMENT.

...ony Inc. Warren, O.

Associated Companies

FLINN & DREFFEIN CO.
THE McKAY MACHINE CO.
LEE WILSON ENGINEERING CO.

QUALITY SHEETS *at* LOW COS



Read what Mr. George E. Bechtel, General Mana
Empire Sheet & Tin Plate Company, Mansfield,
says about Flinn-Dreffein Furnaces:

"To maintain production schedules, to normalize for quality
to produce at proper cost, Empire Sheet & Tin Plate Comp
has depended upon the Flinn-Dreffein Normalizing
nace.

"All of the above are essential to meet se
and production problems.

"The Flinn-Dreffein Normali
Furnace has fulfilled
of these req
me

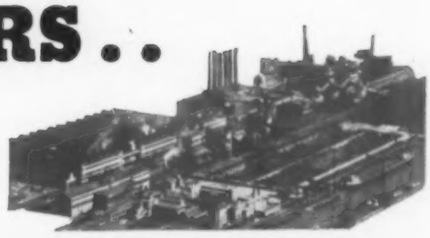
Photo of Flinn-Dreffein Furnace taken in Mansfield plant, Empire Sheet & Tin Plate Co., one of the most efficiently equipped plants in the world.

FLINN & DREFFEIN COMPANY
CHICAGO, ILLINOIS

Associate Company.

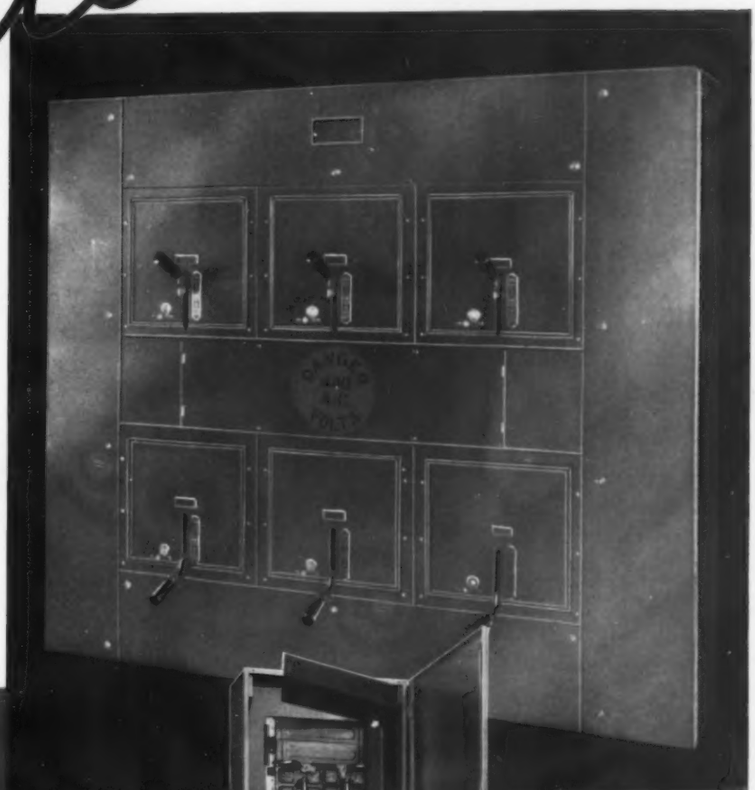
The **WEAN ENGINEERING CO., Inc.**
Warren, Ohio

FOR OVER 25 YEARS..



The Leader

BULL DOG POWER DISTRIBUTION SYSTEMS



Master Panels and Branch Feeder Panels—used in Ford Motor Co. Rouge Plant.

Adopted by Large Industrials for Convenience and Flexibility

We are proud of our record of Service with the Major Industries. BULL DOG originated and pioneered the idea of the SAF-to-FUSE panel, created the design and set the standard for the modern Dead Front Convertible Power Distributing Panel, combining the highest degree of safety with the greatest degree of Flexibility! For maximum service efficiency, dependability and utmost economy, insist on BULL DOG installations.

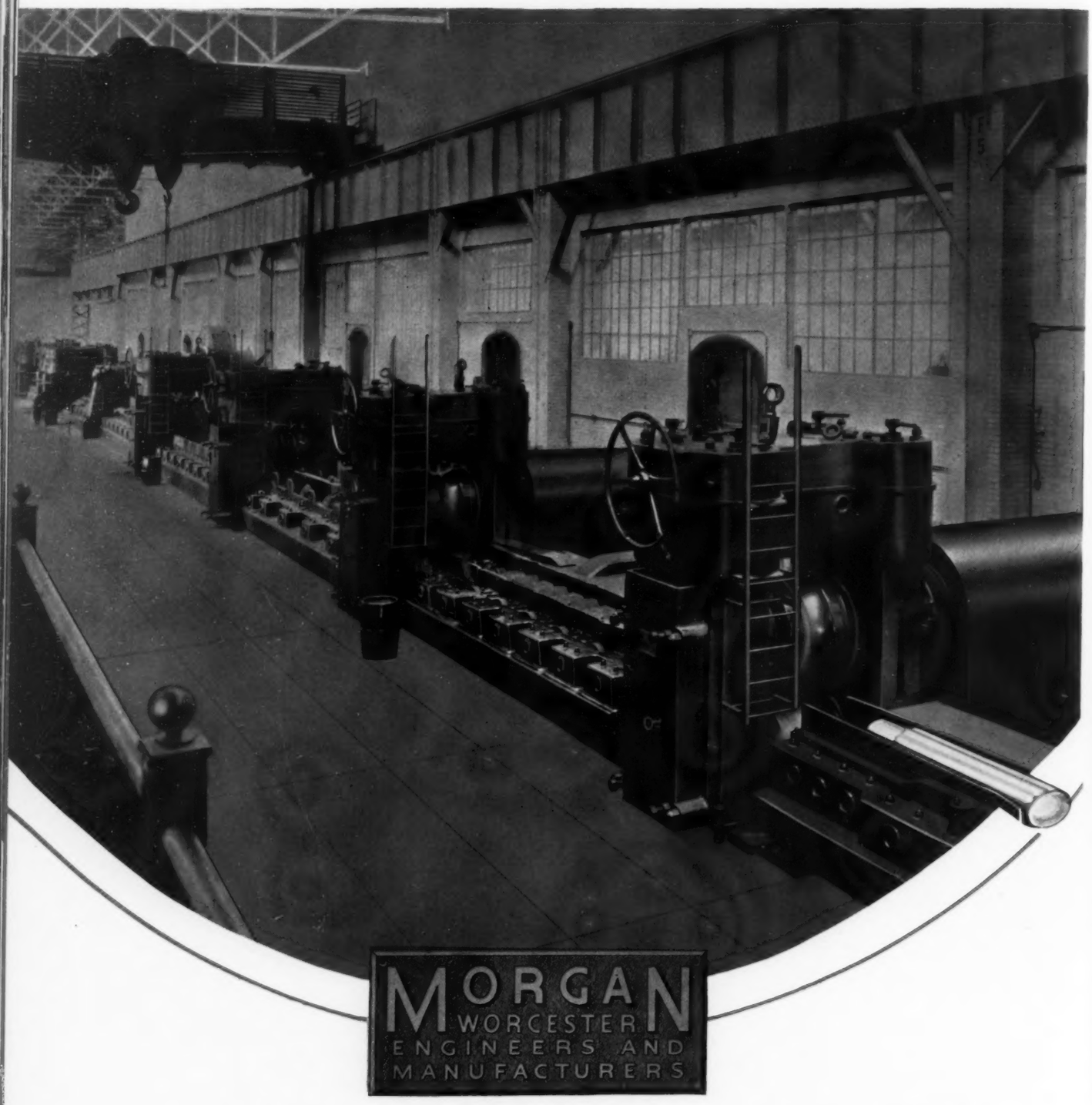
INVITATION

VISIT OUR BOOTHS
Nos. 129 and 130

See with your own eyes the amazing *Vacu-Break* principle of CIRCUIT RUPTURING

BULL DOG ELECTRIC PRODUCTS CO.

DETROIT, U.S.A. Bull Dog Electric Products of Canada, Ltd., Toronto, Ontario.



MORGAN
WORCESTER
ENGINEERS AND
MANUFACTURERS

Four stand 42" Continuous Blooming Mill with four stand 32" Continuous Billet Mill in the background, all driven by a 3 phase 60 cycle 13,200 volt polyphase wound rotor induction motor rated 8000/3000 HP with external switching for delta-Y connection.

R15

WATCH THE FORDS GO BY

Appreciation

is expressed to the Ford Motor Company which from its inception, determined that its products should ever merit public confidence; and which, by so doing, established standards of excellence throughout allied industries.

That this is an expression of mutual appreciation is demonstrated in the fact that Ford, demanding the best in production equipment, has specified Morgan Rolling Mills.

4—Stand—42" Continuous Blooming Mill
4—Stand—32" Continuous Billet Mill
10—Stand—14" Semi-Continuous Merchant Mill
6—Stand—18" Continuous Sheet Bar and Billet Mill
8—Stand—12" Semi-Continuous Spring Mill
16—Stand—10" Semi-Continuous Merchant, Rod and Strip Mill

MORGAN CONSTRUCTION COMPANY

WORCESTER, MASSACHUSETTS, U. S. A.

Visit Booths 166-167, A.I. & S.E.E. EXPOSITION, Convention Hall, Cass Ave., Detroit, Mich., Sept. 22 - 25, 1936

WATCH THE FORDS GO BY

CLARK-SUNDH CONTROL

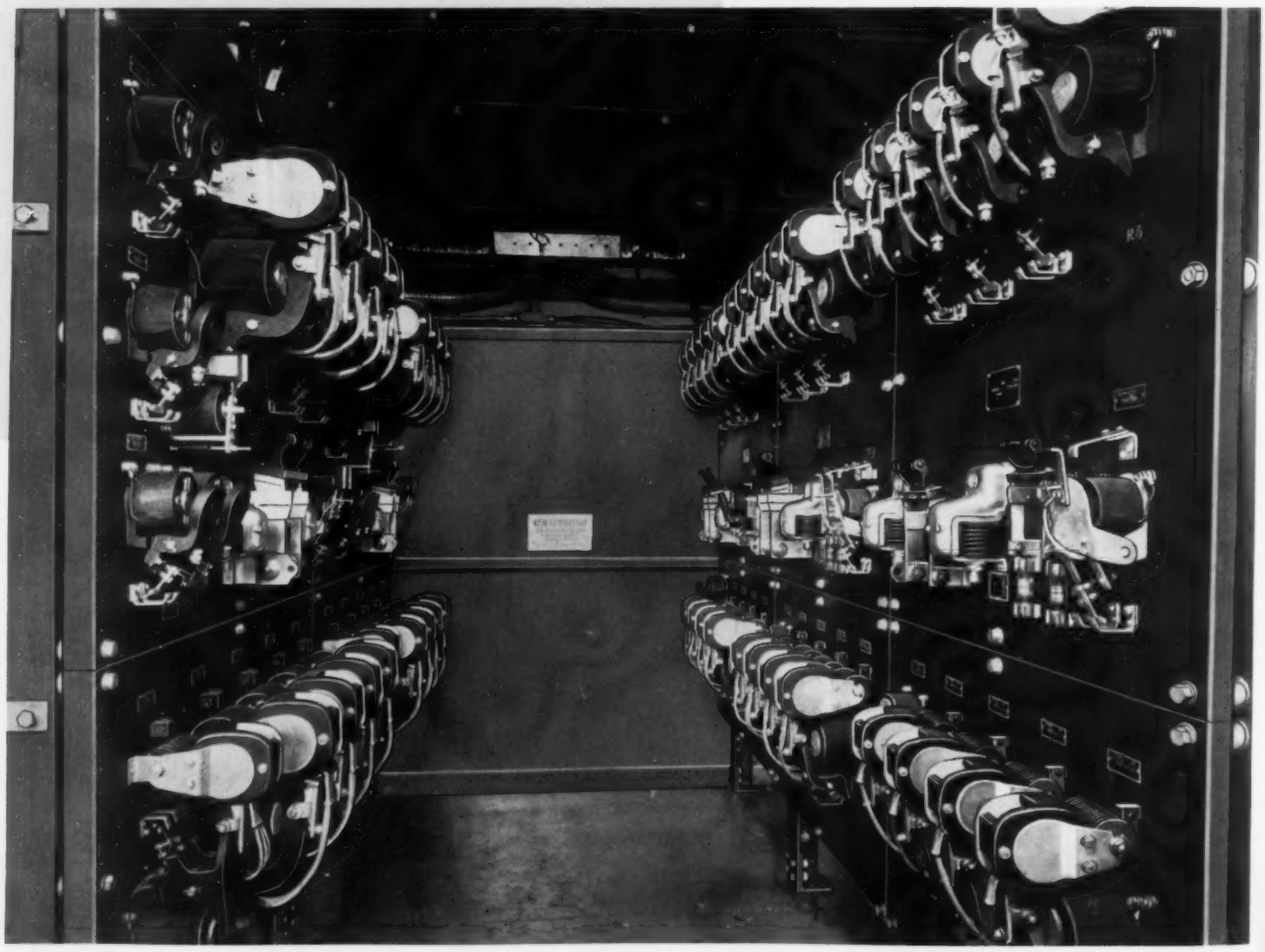
For Standard and Special Drives in all classes of Industry.

- Automatic Roller and Catcher Tables for 2-High and 3-High Mills.
- Automatic Pre-Set Screwdowns.
- Continuous Annealing Furnaces.
- Continuous Strip Pickling Process.
- Strip Coilers and Uncoilers.
- Cut-to-Length Equipment.
- Paper Mill Super-Calendars.
- Rubber Tire Machines.
- Rubber Calendar Equipment.
- Air Bag Inserting Machines.
- Knee Action Spring Coilers.
- Pair and Pack Furnaces and Conveyors.
- Continuous Furnace Lines.
- Glass Polishing.
- Power Presses with Anti-Repeat Feature.
- Hazlett Mills.
- Wire Drawing.
- Tube Drawing.
- Roll Lathes and other Special Machine Tools.
- Charging Machines.
- Electric Overhead Traveling Cranes, A.C. and D.C.
- Runout Roll Tables.

The above just gives you a fair idea of our activity. We have a complete line of A.C. and D.C. Brakes, Flexible Couplings, Automatic Control for Pumps, Fans and other Building Equipment.

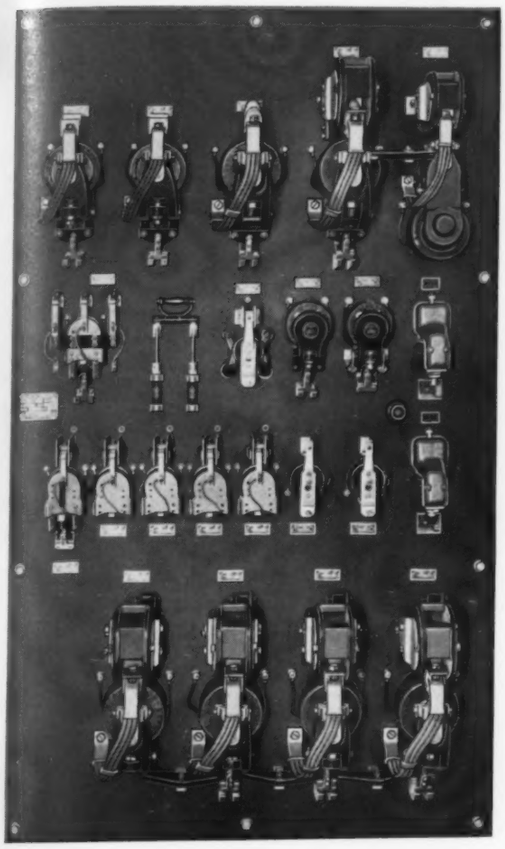
Our Catalog is interesting and is yours for the asking.

Operator's Bench-Board Type of Master Control Station



Crane Control Panels on 90 Ton Crane

Majoring in Special Applications



Above is a view of one of the many special automatic control panels designed and built for use in connection with the modern continuous sheet pickling lines. Our pioneer work in this connection has given us the necessary experience on which to base correct and complete recommendations covering the proper control for each motor driven unit in the entire line.

Below is a view of a
CLARK "3C" MAGNETIC BRAKE
installed on one of the units operating in a modern continuous sheet pickling line.

Visit our Exhibit at the
IRON AND STEEL EXPOSITION
to see the improvements that have been made in Magnetic Brakes and Magnetic Contactors.
Look for the "CLARK TOWER".
Space Nos. 32-33-58 and 59

The CLARK CONTROLLER Co.
1146 E. 152ND ST. CLEVELAND, O.

BUILT BY MORGAN *Engineering* » »

Morgan Crane HANDLING COILS FOR FORD

● In the world-famed Ford operating efficiency, materials handling equipment is naturally given its proper importance in the scheme of production. Perhaps nowhere else exists a stricter regard for safety, economy and genuine efficiency. Here is shown a Morgan 15-ton, 86′0″ span crane handling coils of strip steel in the Ford steel plant at River Rouge. It is one of the 56 Morgan Cranes used in the Ford Motor Company plants—ranging in size from 5 to 125-tons capacity. To the rugged durability of the Ford car, Morgan contributes the sturdy dependability of its own good name, a reputation 65 years in the making.

★

★

★

★

★

DESIGNERS • MANUFACTURERS • CONTRACT

BLOOMING MILLS • PLATE MILLS • STRUCTURAL M

ELECTRIC TRAVELING CRANES • CHARGING MACH

INGOT STRIPPING MACHINES • SOAKING PIT CRA

ELECTRIC WELDED FABRICATION • LADLE CRA

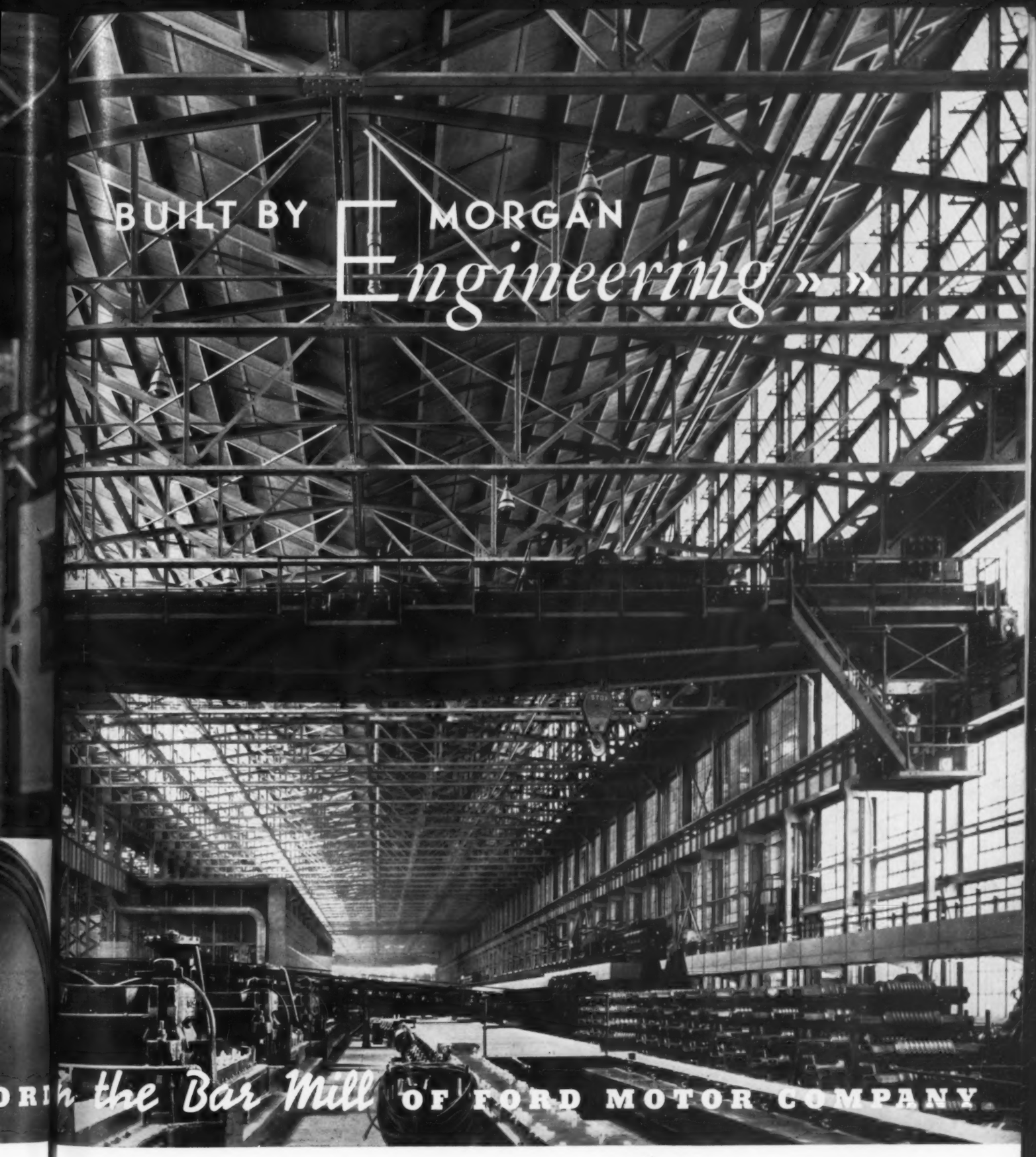
STEAM HAMMERS • STEAM HYDRAULIC FORG

PRESSES • SPECIAL MACHINERY FOR STEEL M

THE MORGAN ENGINEERING CO., Alliance, O

Pittsburgh, 1420 Oliver Bldg. New York, 11 W. 42nd S

ere is or
gan Cra
Ford Mo
ge plant
every ki
e for th
fe crane
structe
dards o



ere is one of the 15-ton, 96′0″ span gan Cranes serving the bar mill of Ford Motor Company in the River ge plant. Like all Morgan Cranes it every known safety device—a safe e for the management to own and fe crane to operate. Designed and tructed to traditional Morgan dards of rugged stability, it is as dependable as the famous motor car it helps to build. After 55 years of crane building, it may be assumed that the reputation earned by Morgan will never be sacrificed merely to sell another crane. Morgan standards are high, but no higher than seems necessary to build a crane to perform dependably and safely over a long period of time.

★

DESIGNERS • MANUFACTURERS • CONTRACTORS

★ BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS

ELECTRIC TRAVELING CRANES • CHARGING MACHINES

★ INGOT STRIPPING MACHINES • SOAKING PIT CRANES

ELECTRIC WELDED FABRICATION • LADLE CRANES

★ STEAM HAMMERS • STEAM HYDRAULIC FORGING

PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

★ **THE MORGAN ENGINEERING CO., Alliance, Ohio**

Pittsburgh, 1420 Oliver Bldg. New York, 11 W. 42nd Street

★

Baker plays a part in FORD production

• In the photograph below is one of several Baker Trucks in operation in plants of The Ford Motor Co.

The Baker Ram Type Hy-Lift, shown here, renders fast and efficient heavy-duty service in the Ford rod-mill, where it must successfully undergo a daily test of strength, stamina, and ruggedness.

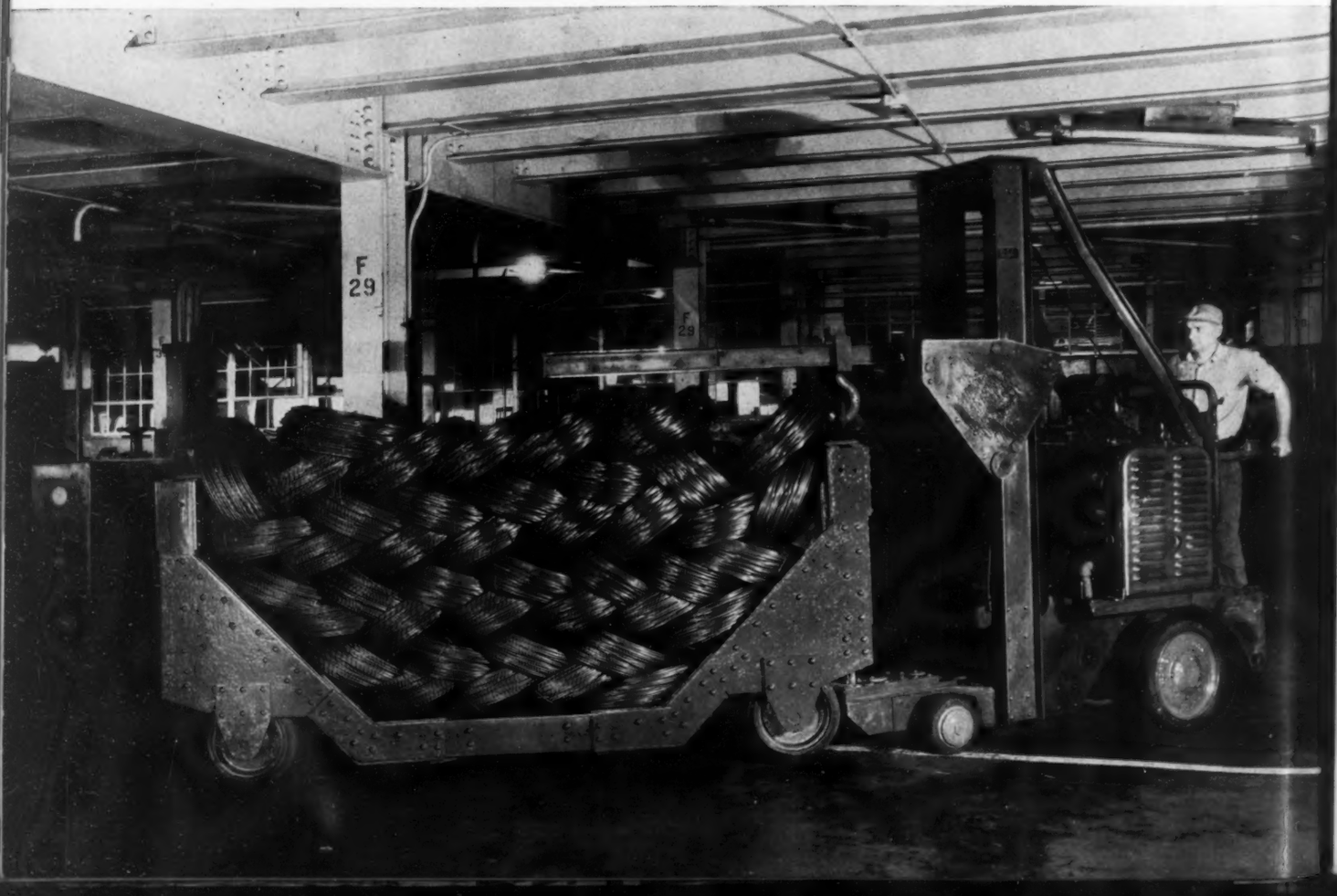
Steel mill operators everywhere comment enthusiastically on Baker's superior huskiness, reporting that Baker Trucks consistently stay in service long after the original investment has been written off and forgotten. Baker builds trucks and tractors for every type of steel mill service. Let us know the type of truck or materials-handling operation which interests you and we will gladly furnish full particulars.

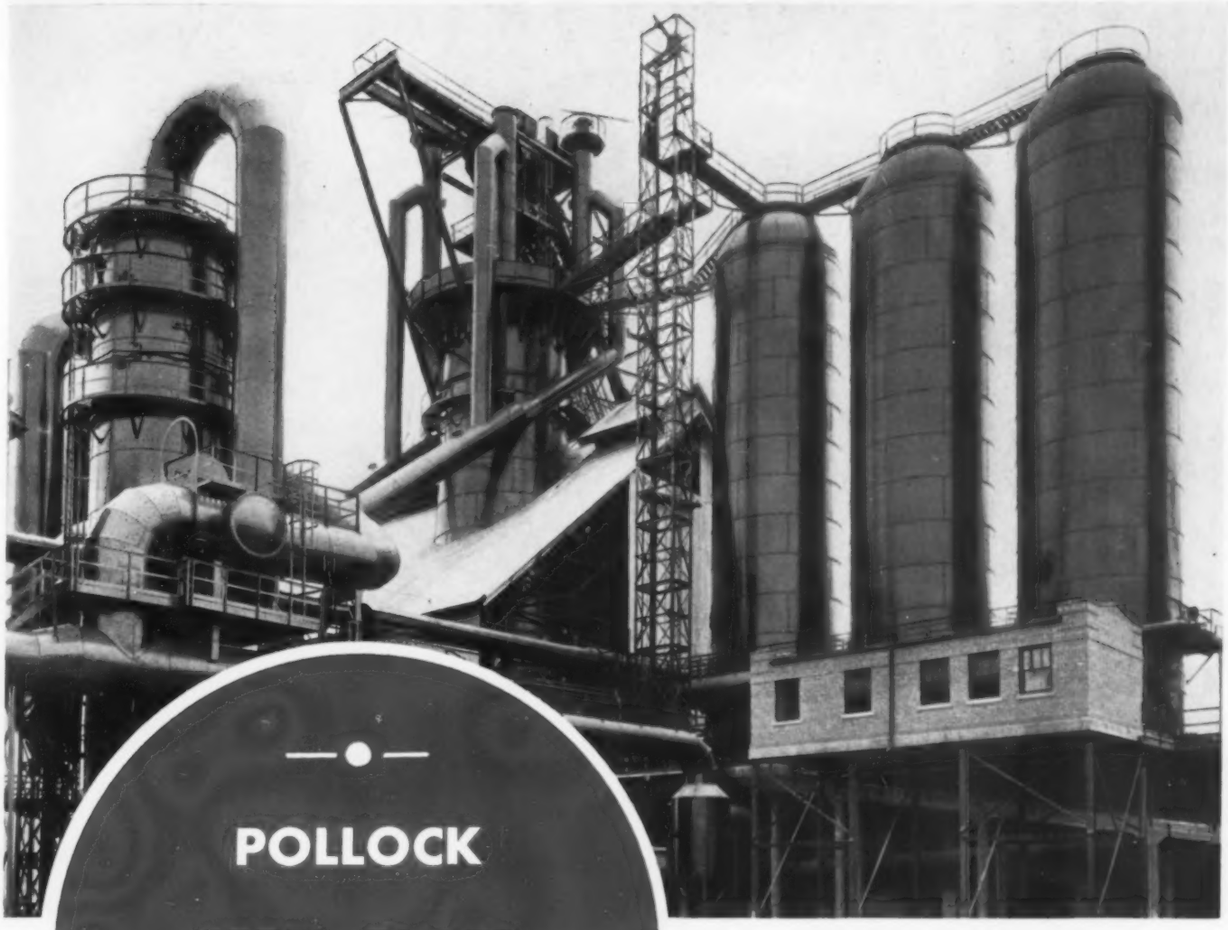
BAKER INDUSTRIAL TRUCK DIVISION
of THE BAKER-RAULANG COMPANY
2166 West 25th Street • • Cleveland, Ohio

TRACTORS Baker TRUCKS

HISTORICAL NOTE

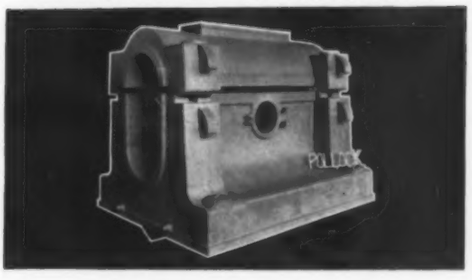
Twenty-five years ago *Baker* . . . then selling electric passenger automobiles and trucks . . . was, to that degree, a competitor to *Ford*. Today, *Baker* having built another business on the foundation of the electromotive pioneering of those earlier days, furnishes equipment to its former competitor.





POLLOCK STEEL PLATE CONSTRUCTION

Blast Furnace Gas Seal Hood

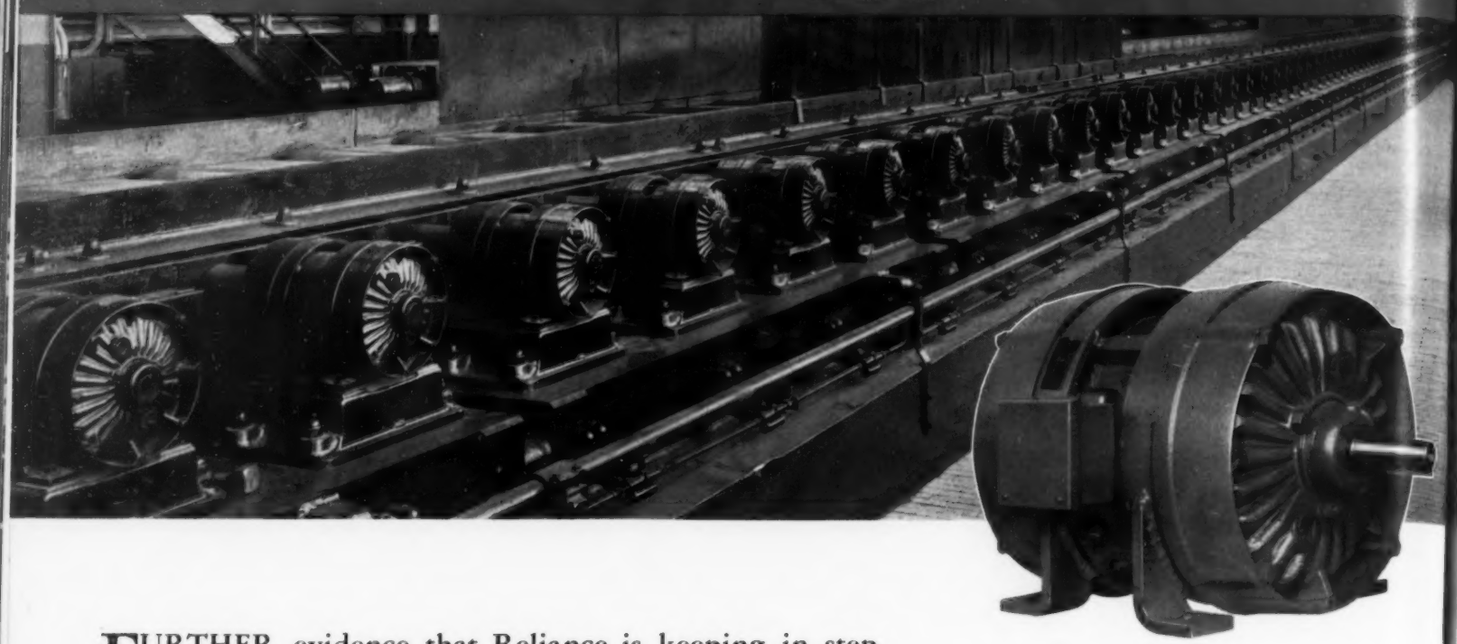


Strip Mill Pinion Stand

For three-quarters of a century, The William B. Pollock Company has been proud of its ability to meet the diversified requirements of major industries. Complete facilities for engineering, fabricating and erecting steel plate work from the lightest gauge to the greatest thickness is demonstrated by their products.

The William B. Pollock Company
Youngstown, Ohio

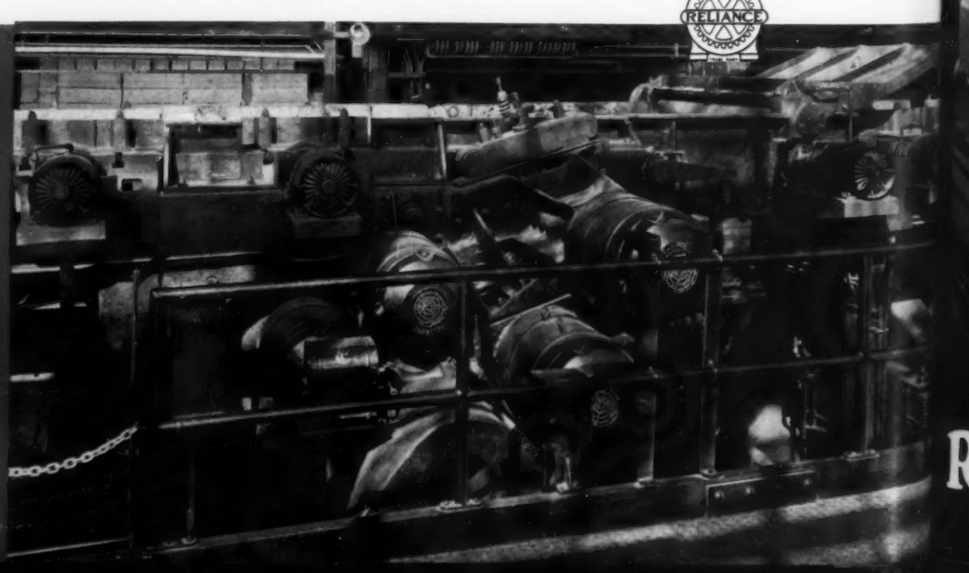
RELIANCE MOTORS



FURTHER evidence that Reliance is keeping in step with Steel is afforded by these installations in the Ford Mills. On run-out tables, coilers, continuous pickle lines, roll grinders and many other applications, are general and special-purpose motors designed with protective features and characteristics to best perform a variety of steel-mill power jobs. With helpful aid from equipment builders and the men in the mills, Reliance has made an intensive effort to anticipate new demands which have come with the continuous processes. There are still new motor-drive jobs ahead. When you have one on the board, call in a Reliance man. He should have something useful to offer.

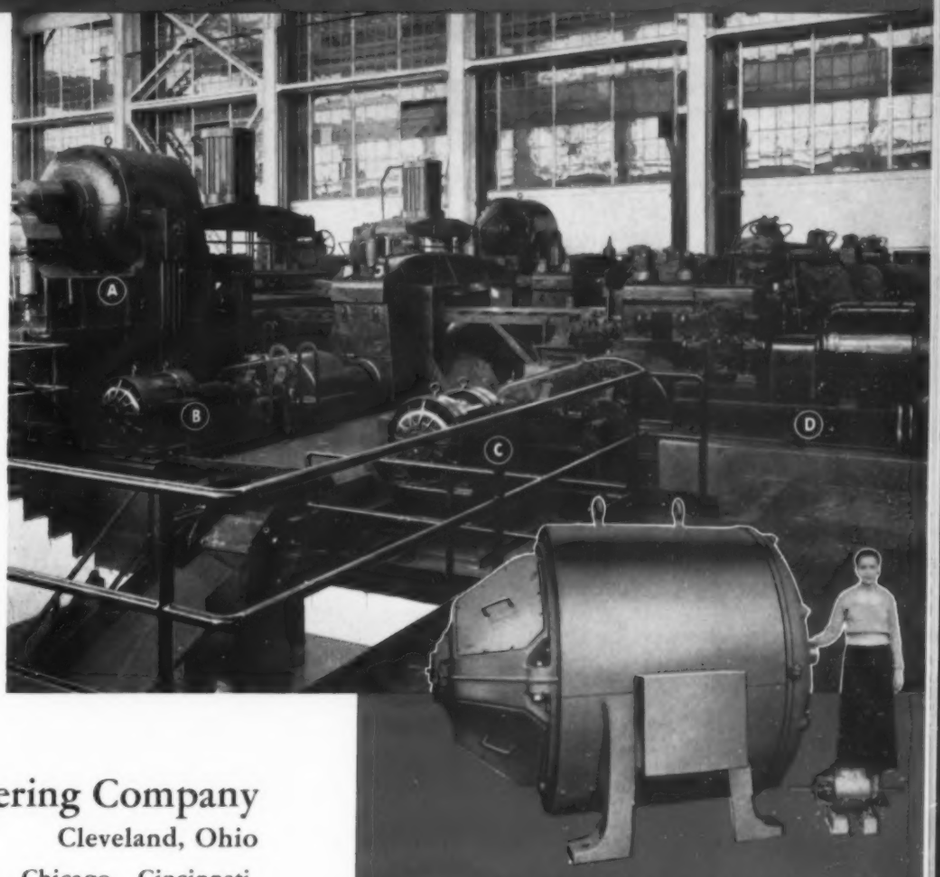
Fully-enclosed Type "AA" Squirrel-cage Motors are direct connected to run-out table rollers. Motors are designed with special torque characteristics for quick starting. (*above*)

Fast, accurate table operation needed for handling maximum tonnage is obtained by variable-frequency speed control and the Reliance system of d-c. dynamic braking. (*above*)



Fan-cooled Reliance Squirrel-cage Motors, supported by flange mountings, are direct connected to each of the coiler rolls . . . To determine the correct motor sizes and design characteristics for a job like this, requires a background of specialized study and experience. Reliance has it.

in the FORD MILLS



Entrance end of Wean Continuous Pickling Line:

(A) 100/125 hp. 300-1200 r.p.m. Fan-cooled Type "T" Heavy-duty d-c. Motor on uncoiler.

(b) 50 hp. Fully-enclosed Type "AA" Squirrel-cage Motor with special torque characteristics for up-cut shear.

(c) 75 hp. special-torque enclosed squirrel-cage motor driving stitcher.

(d) 15 hp. 400-1600 r.p.m. fan-cooled d-c. motor for stitcher pinch roll.

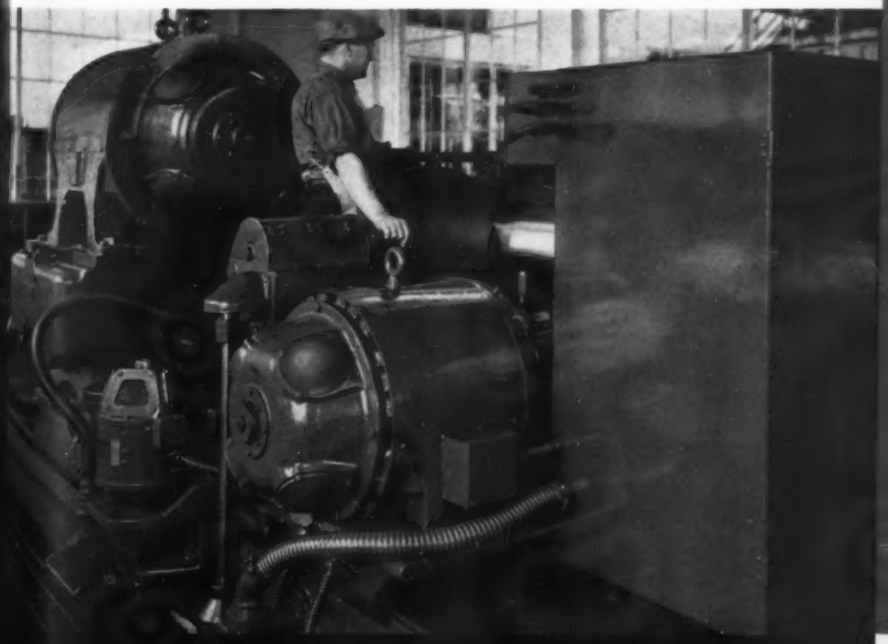
Above—Adjustable-speed Type "T" Heavy-duty Fan-cooled d-c. Motor as used for driving various units of continuous pickling line and other machines in finishing departments.

Reliance Electric & Engineering Company

1088 Ivanhoe Road Cleveland, Ohio

Branches: Birmingham, Boston, Buffalo, Chicago, Cincinnati, Detroit, New York, Philadelphia, Pittsburgh

Representatives in other principal cities



At the left—In supplying motor-drives for roll grinders, Reliance is accustomed to pleasing two particular parties—the builder and the user. Only with an accurately-built, perfectly-balanced motor can the grinder produce on the rolls the mirror finish so necessary for rolling high quality strip.

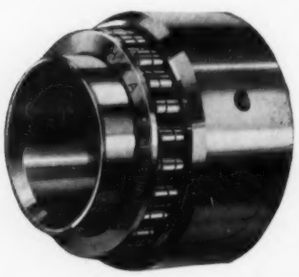
Three fan-cooled d-c. adjustable-speed Type "T" Heavy-duty Motors and three constant-speed motors are used on this grinder.

RELIANCE A-C D-C MOTORS

Motor units such as these play a big part in lowering tonnage costs—Don't overlook their importance.

When extra *Load Capacity* counts.... count on HYATT!

Unseen, unheeded, these high-capacity bearings handle their appointed tasks silently, smoothly, efficiently. Years of hard service in all types of equipment, under all kinds of conditions, do not lessen their original accuracy, strength, or performance. Hyatt Roller Bearing Co., Newark, Detroit, Chicago, Pittsburgh, San Francisco.



In the Steel Plant of the **FORD MOTOR COMPANY** Hyatt Roller Bearings are used in the mill tables, the motors, etc. to assure that dependable operation which these better bearings always make possible.

Relies on DINGS
For Screwdown Synchronization

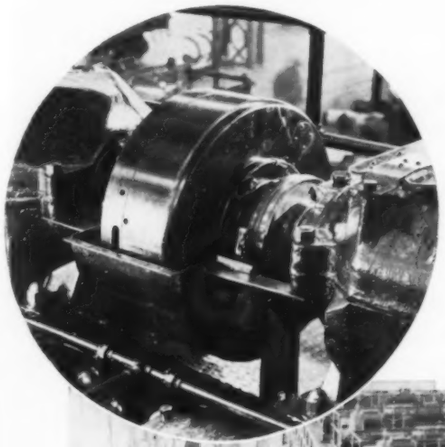
HERE is another great plant to add to the long list of strip steel plants using Dings Magnetic Clutches on the screwdowns—Ford at River Rouge.

Such names as Ford, Carnegie-Illinois, Sharon Steel Corp., Republic Steel, Jones and Laughlin and many more of almost equal fame form a silent endorsement that should weigh heavily with any one with the problems that a Dings Magnetic Clutch can solve.

Dings Magnetic Clutches solve the synchronization problem that lies in the use of the two driving units on the screw downs.

But yours may be a different problem. Dings Magnetic clutches are ideal for remote control. They solve problems of safety, high WR^2, slippage, end thrust, cycle or occasional coupling or uncoupling actuated by mechanical or manual means or any combination of these requirements.

It is best to be sure so if you have any kind of a clutch problem put it up to Dings Engineers. There is of course, no obligation.



View of Finishing Mill at Ford River Rouge Plant showing 6 Dings clutches. Dings Magnetic clutches are also used on the screwdowns of the roughing mill

DINGS MAGNETIC SEPARATOR CO.
662 SMITH STREET
MILWAUKEE,
WISCONSIN

Dings High Intensity MAGNETIC CLUTCHES

Separation Headquarters Since 1899

For Heavy Drives

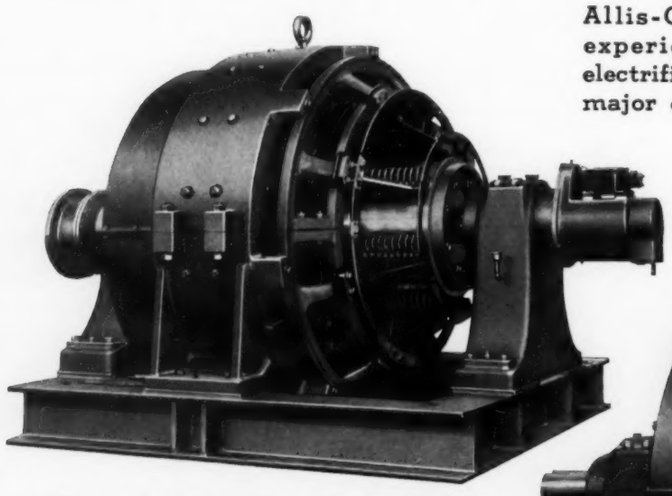
Direct Current Synchronous Wound Rotor Motors...

● In following up the trend of steel mill and other plant modernization you will always find Allis-Chalmers engineering and electric drive in the foreground.

Allis-Chalmers direct current motors, with "Frogleg" windings, are inherently 100% cross-connected. They stand heavy over-loads without commutator troubles or flashovers.

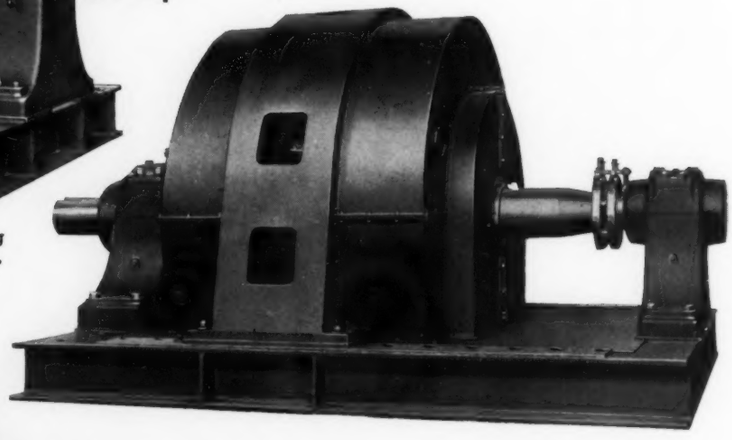
Synchronous and wound rotor motors are built to fully meet the exacting requirements of hard, continuous service. Their well balanced design has earned for them the highest reputation for satisfactory operation.

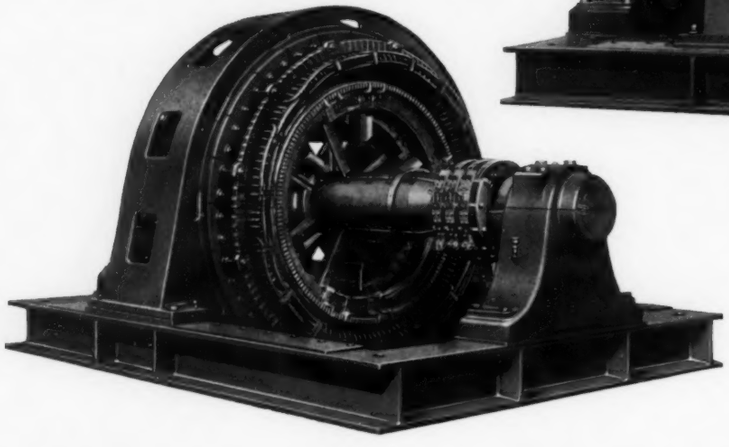
Allis-Chalmers engineers have had a broad experience in steel mill and industrial plant electrification. Call upon them when considering major or minor ideas affecting modern practices.



Above: One of two Direct Current Rolling Mill Motors, 600 hp, 400/800 rpm, 230 volts.

These machines are representative of those recently built by Allis-Chalmers for the new Ford Steel Mill.



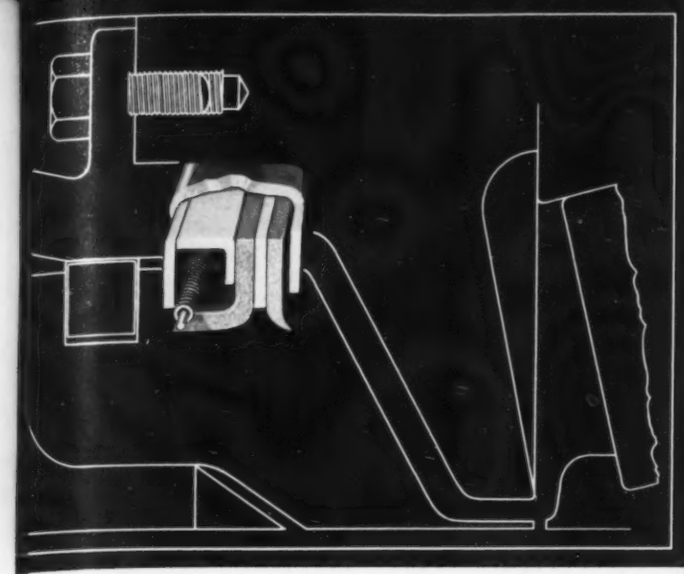


Above: One of three 2500 hp, 514 rpm, 13,200 volts Enclosed Separately Ventilated Synchronous Rolling Mill Motors.

Left: 2500 hp, 600 rpm, 13,200 volt Enclosed Separately Ventilated Wound Rotor Rolling Mill Motor with enclosures removed to show construction.

ALLIS-CHALMERS

— Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin, U.S.A. —



Perfect

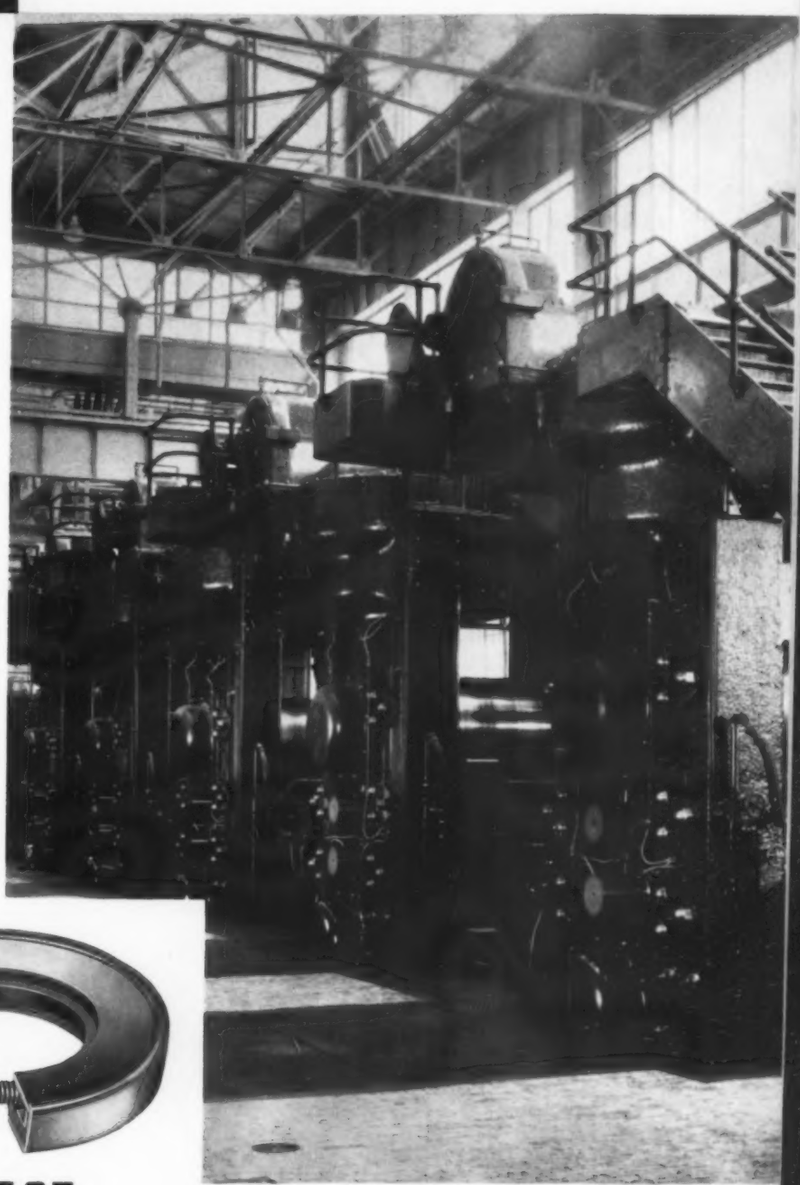
OIL SEALS PROTECT ROLL NECK BEARINGS

THE bearings on these mills in the Ford Plant are equipped with "Perfect" Oil Seals. The Seals used for this purpose retain bearing lubricant and exclude dirt, water, mill scale and other materials disastrous to such bearings.

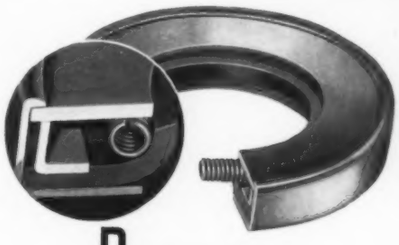
"Perfect" roll neck seals (up to 48" O.D.) are especially designed for mill service. The leather packing member which has self-lubrication properties will not score the shaft. This member is held solidly in place by the construction of the seal.

A non-collapsible tension spring which cannot be dislocated or flattened exerts an accurately calculated pressure between the wiping lip of the packing member and the shaft. This pressure is constant and uniform at all points on its circumference. The amount of pressure is just sufficient to accomplish adequate sealing—not enough to build up friction resistance.

"Perfect" Oil Seals are available for Work Rolls, Back-Up Rolls, Table Rolls, Reduction Units and Screw-down mechanisms—also wherever a rotating or reciprocating shaft bearing needs protection. Install this protection and reduce your bearing maintenance.



Courtesy of United Engineering & Foundry Co.



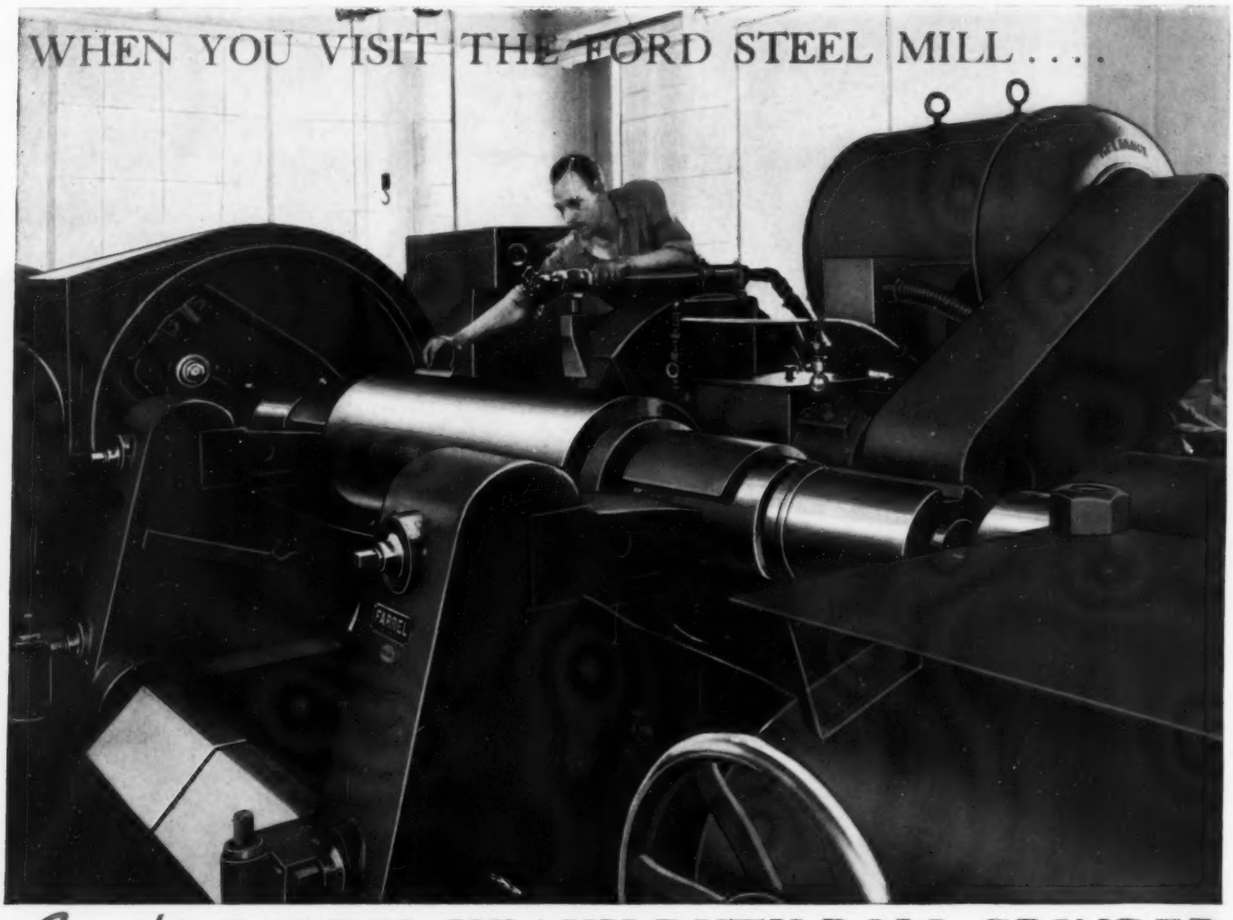
PERFECT
Oil Retainer
PATENTED

CHICAGO RAWHIDE MANUFACTURING COMPANY

1307 ELSTON AVENUE, CHICAGO, ILLINOIS

57 Years Manufacturing Quality Mechanical Leather Goods Exclusively

PHILADELPHIA • CLEVELAND • NEW YORK • DETROIT • BOSTON • PITTSBURGH • CINCINNATI



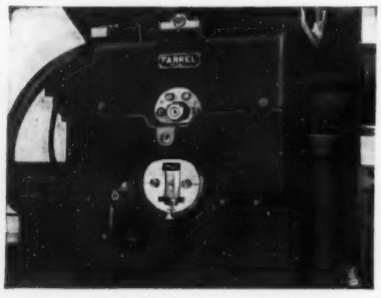
See this FARREL HEAVY DUTY ROLL GRINDER

WHEN YOU VISIT

The Iron and Steel Exposition

Stop

at Booth No. 44 and see the working model demonstrating the operation of the Farrel Cambering Attachment.



The Farrel Cambering Attachment always produces an accurate and symmetrical crown or concavity.

If you are responsible for roll grinding operations in your mill and are interested in higher accuracy, better finish, more production and lower grinding costs, don't miss the opportunity to see the Farrel Heavy Duty Roll Grinder during your inspection trip through the Ford steel mill.

See for yourself the kind of a job it does. Observe its smooth, vibrationless operation. Compare its performance with other machines on similar work.

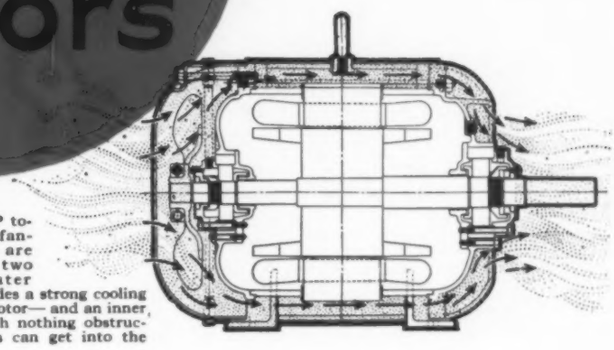
Farrel Heavy Duty Roll Grinders are designed for better, faster and cheaper grinding to the extreme limits of accuracy required by modern steel mill practice. They are *production* and *precision* machines equally capable of taking the heaviest cuts in rough grinding and of applying the finest mirror finish to rolls of all types.

Our engineers at Booth No. 44 at the Iron and Steel Exposition will be glad to explain the details of design which underlie the exceptional performance and operating economy of Farrel Heavy Duty Roll Grinders.

FARREL-BIRMINGHAM COMPANY, INC.

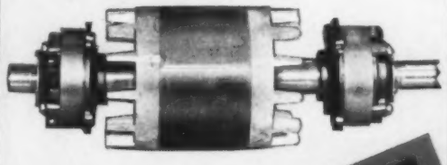
42 Main St., Ansonia, Conn.

FOR DEPENDABLE SERVICE USE Wagner Motors



Wagner type CP totally-enclosed fan-cooled motors are provided with two frames—an outer frame which guides a strong cooling draft over the motor— and an inner frame thru which nothing obstructive or injurious can get into the motor.

Wagner CP stator— rugged, welded all-steel frame especially impregnated and fully taped winding, deeply grooved periphery to increase radiating surface,—built to meet the exacting strains of hard, continuous service.



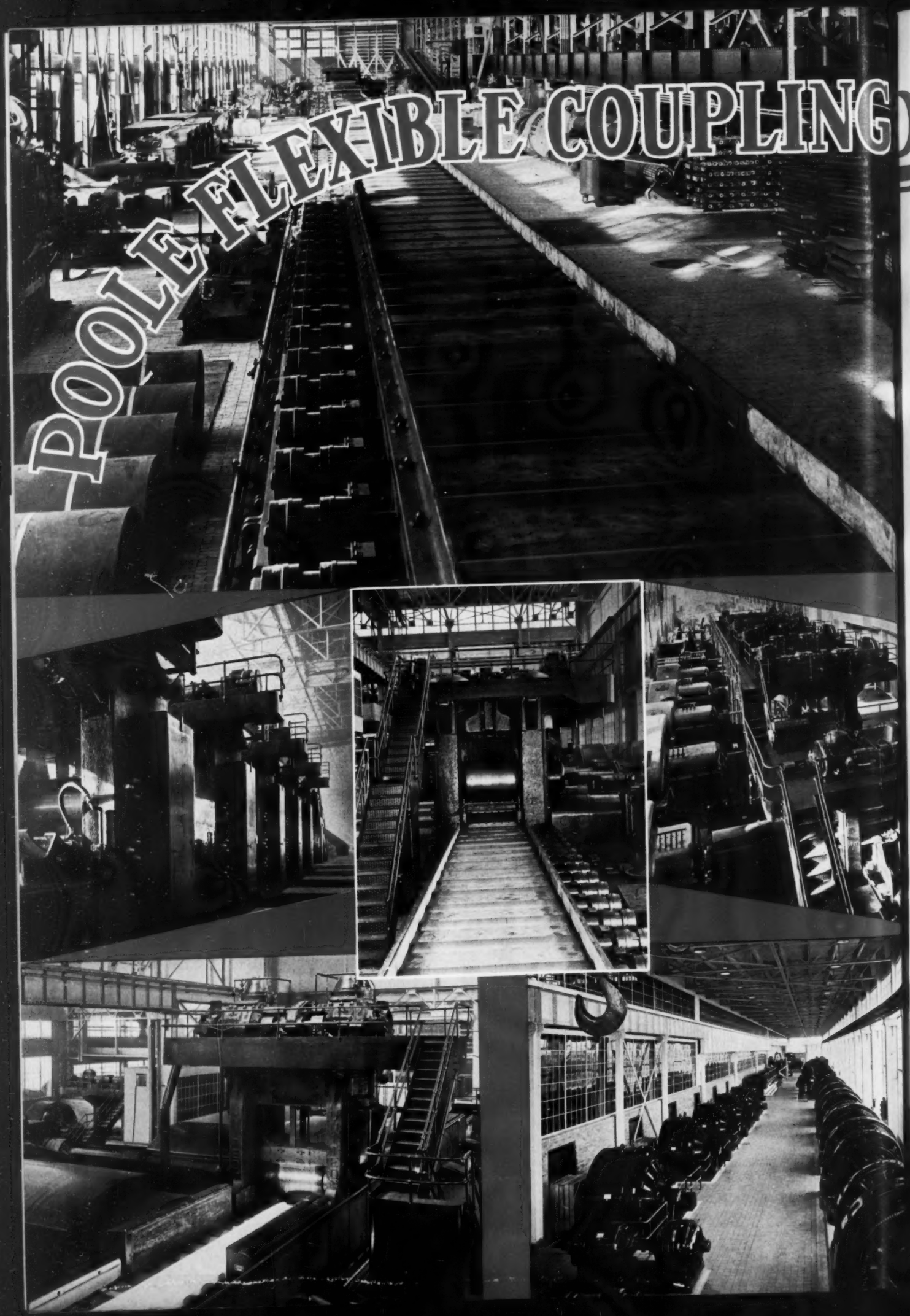
Wagner CP rotor—dynamically balanced to insure freedom from vibration; cast aluminum blowers, bars and rings; full cartridge-type ball bearings—built substantially to operate smoothly, efficiently and dependably under hard, continuous service.

Visit WAGNER BOOTHS No. 179-180 Iron & Steel Exposition Detroit, Mich. Sept. 22-25

WAGNER totally-enclosed fan-cooled type CP motors are a big aid toward preventing unnecessary maintenance and subsequent losses due to curtailed production. They are built to meet the severe operating conditions encountered in the steel industry. Their strong and rugged frame construction is one assurance for long dependable service. Their totally-enclosed fan-cooled design makes them ideal for operation in atmosphere laden with iron dust, fumes, moisture and other injurious agents which would otherwise short-circuit and corrode the motor.

NL236-4F

Wagner Electric Corporation
6400 Plymouth Avenue, Saint Louis, U.S.A.


POOLE FLEXIBLE COUPLING

NGOMINATE AT FORD

All Metal
Forged Steel
No Welded Parts

OIL TIGHT -- DUST PROOF

The Poole flexible coupling combines great mechanical strength with an unusual capacity for adapting itself to ordinary shaft misalignments. It has no springs---rubber---pins---bushings---die castings or any flexing materials that require frequent replacement.

Using strong specially treated steel forgings, long wearing gears in constant bath of oil, this coupling eliminates your coupling troubles.

Send for a copy of our Flexible Coupling Handbook.

BE SURE TO VISIT THE POOLE FLEXIBLE COUPLING DISPLAY

BOOTH 165, IRON & STEEL EXPOSITION, DETROIT

September 22-25, 1936

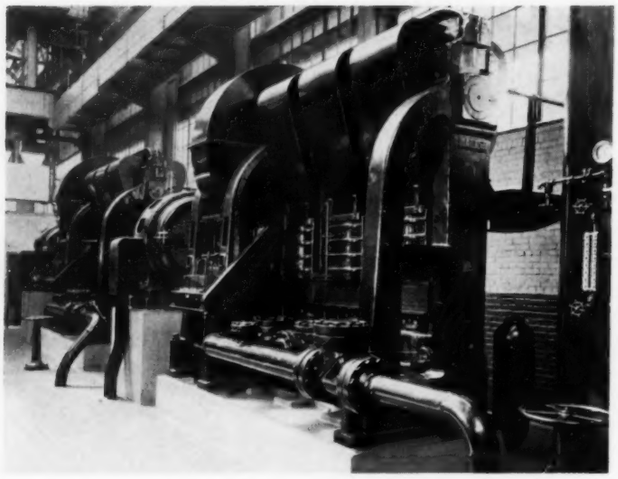
Poole Foundry & Machine Company

Baltimore, Maryland

FORD CHOSE

The ALDRICH DESCALING SYSTEM

FOR ITS NEW ROUGE 48 in. CONTINUOUS HOT STRIP MILL



The complete ALDRICH SYSTEM includes:

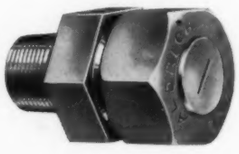
Two 7″ x 18″ Aldrich Vertical Triplex Pumps as illustrated; 600 G.P.M. each at 1000 pounds per square inch pressure.

A 400 horsepower motor drives each pump and proves the pump's high efficiency.

Pumps are fitted with Patented Holveck Synchronized Suction Valve Control and operate in conjunction with a 2500 gallon Hydro-Pneumatic Accumulator, shown at right in picture.

Control of flow to Nozzle manifolds is automatic by thrustor operated valves.

System is capable of supplying a variable volumetric demand range from zero to maximum with uniform flow at a pressure range of 950 to 1000 lbs. per sq. in. Eighty Aldrich Patented Spray Nozzles give perfect descaling at five points of top and bottom application. Certain nozzles are equipped with shut-off valves to conserve water when rolling narrow strip.



Aldrich "Patented" Spray Nozzles for descaling are of the highest efficiency and are Laboratory tested. Beware of inefficient imitations. Made of highest grade steel in standard sizes for shipment from stock.

Illustration shows application of Aldrich Nozzles at one stand in the Ford Mill.
Steel guards are so placed as to prevent rise of fog.

Forty years in the production of high efficiency Triplex and Quintuplex Reciprocating High Pressure Power Pumps led Aldrich to pioneer in the development of Spray Nozzles and Pumping systems for Descaling purposes. This leadership Aldrich maintains.

Aldrich Engineers are prepared to analyze your Descaling problem and to make recommendations and contract for complete Descaling Systems. Or if you have any Hydraulic Pump problems, write to:—

ALDRICH

THE ALDRICH PUMP COMPANY

ALLENTOWN, PENNSYLVANIA

No. 1 and No. 2 three-hole soaking pits at Rouge plant of FORD Motor Company

Redesigned and Built by Criswell

Above pits redesigned and erected at Rouge Plant of Ford Motor Co. during 1935. At the present time CRISWELL is making similar changes to seven additional Soaking Pit Furnaces.

Members of this organization have had over 35 years of experience in the designing and building of open hearth furnaces, soaking pit furnaces and heating furnaces.

Why not let us discuss your problems in this field?

Designers and Builders

Open Hearth Furnaces, Regenerative Type Soaking Pits and Heating Furnaces

JAMES CRISWELL COMPANY

KEENAN BUILDING - - - PITTSBURGH, PA.

Open hearth control panel at Ford Motor Company, Rouge Plant, containing Bailey Furnace Pressure Recorder-Controller and Bailey Fuel Flow—Air Flow Meter.

REDUCE
OPEN HEARTH COSTS
WITH
BAILEY CONTROL

● When Bailey Control of Furnace Pressure and Fuel Flow—Air Flow Ratio are applied to the open hearth, substantial savings are effected. These controls shorten heats, lengthen campaigns, and reduce fuel consumption by providing peak flame temperatures with maximum protection of furnace refractories.

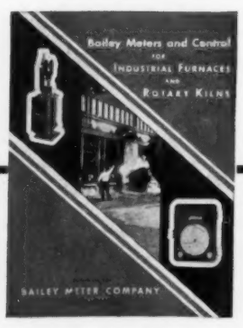
Though the application of either Bailey Furnace Pressure Control or Fuel Flow —Air Flow Control alone can be justified from the improvements secured, a combination of both types of control proves more than doubly worth while since each improves the functioning of the other. With proper coordination of furnace pressure and combustion as maintained by this equipment, most economical operating conditions can be adopted as standard practice.

Your free copy of Bulletin No. 104, describing Bailey Air-Operated Control for open hearth furnaces, will be mailed promptly upon receipt of the coupon below.

Mail it today.

Send for this New Bulletin

BAILEY OPEN HEARTH CONTROL



S-4

BAILEY METER COMPANY
1047 IVANHOE ROAD, CLEVELAND, OHIO
CANADIAN ADDRESS • MONTREAL, CANADA

Gentlemen: Kindly send me a free copy of Bulletin No. 104 describing Bailey Open Hearth Furnace Control.

Name_____

Company_____

Street_____

City_____ State_____

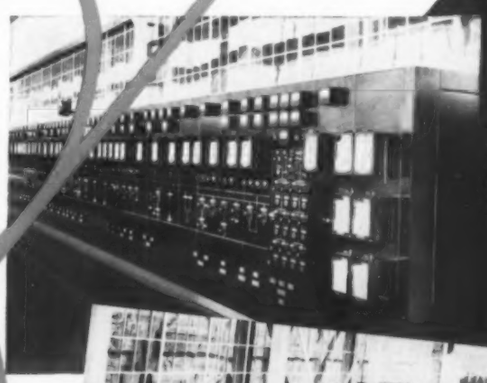
FORD ENGINEERS

CHOSE WESTINGHOUSE DRIVES

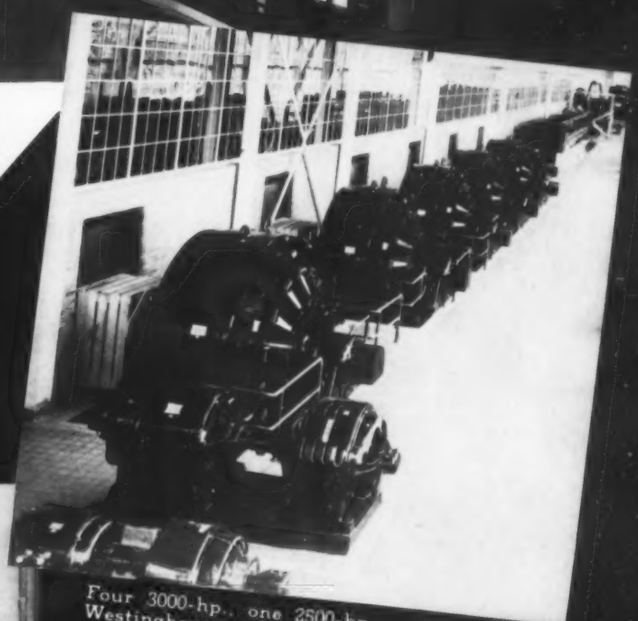
for their hot strip mill finishing stands

AT DEARBORN, MICHIGAN

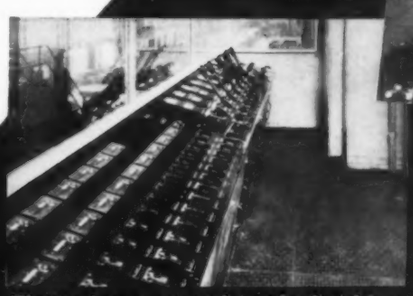
The exacting requirements of Ford engineers when they buy equipment are well-known. • That they chose Westinghouse motors and control for their hot strip mill finishing stands is convincing evidence of the correctness of Westinghouse steel mill drives.



Westinghouse factory-assembled control board installed in the Ford hot strip mill.



Four 3000-hp., one 2500-hp., and one 400-hp. Westinghouse d-c. mill motors driving the finishing stands at the Ford steel plant at Dearborn, Michigan. On your inspection trip notice the excellent commutation of these motors.



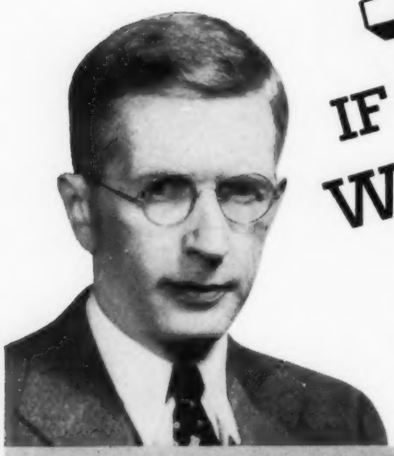
Westinghouse control in the finishing mill pulpit control room.

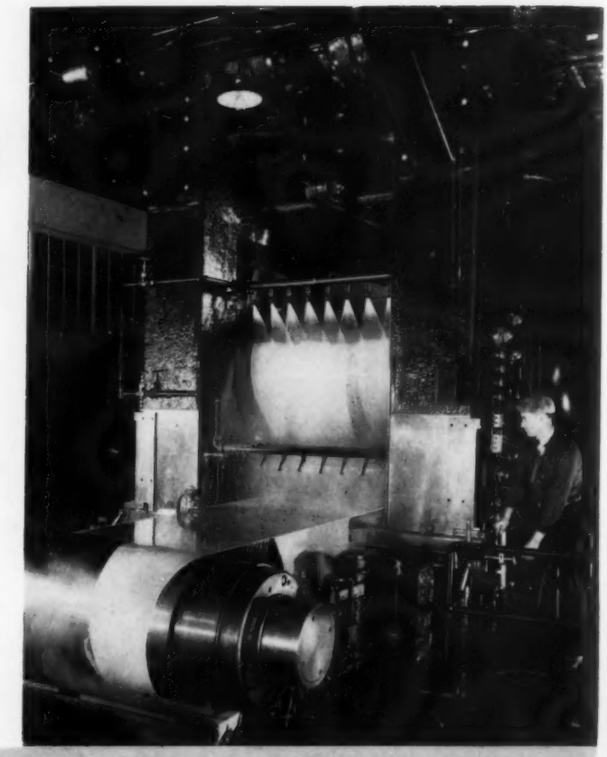
WESTINGHOUSE 1886 GOLDEN JUBILEE 1936

Westinghouse

J 20159

HOW TO HANDLE IT IF IT IS WATER





Rex Spray Nozzles in action in the Ford Steel Mills.

THESE NOZZLES CLEAN BETTER WITH LESS WATER

● Just this one little item in the Rex line of Water Handling Equipment—these Rex Spray Nozzles are saving thousands of dollars per year in cleaning and washing materials, raw steel and finished products, including de-scaling in hot strip mills, regulating roll and strip temperatures in cold strip mills, washing after pickling and many other steel mill and industrial processes. The flat, hard-hitting spray, economy of water and freedom from trouble make these nozzles ideal for general use.

Rex Water Handling Equipment includes:

Bar Screens		Screening intake water
Sludge Pumps		Handling suspended and settled solids
Sludge Collectors	*for*	Recovering trade wastes
Grit Collectors		Reclaiming water
Nozzles		Reclaiming chemicals

Waiting to be sent to you is a new book: "How to Handle IT," which shows 6 cases of liquid handling and 42 other cases of cost-cutting handling in 21 industries. Send for your copy and we will send a copy of the folder on the Rex Spray Nozzle that also cleans better with less water.

CHAIN BELT COMPANY
1688 W. Bruce St., Milwaukee, Wis.

REX

CHAIN BELT COMPANY *of* MILWAUKEE

Chain and Belt Conveying

Universal Magnet...

EC&M No. 8 Type SA Magnet handling 9850 lbs. of pig iron

Illustrated below is an E C & M 85 inch diameter Type SA Magnet placing a 18,000 lb. coil of strip steel in position for annealing in electric furnace.

Three Hot Ingots, shortly after being removed from the ingot molds, are handled by the EC&M No. 8 Type SA Ribbed case Magnet shown above. Total lift, 18,000 lbs.

THE EC&M Ribbed-case TYPE SA

Look at these lifts of scrap and raw, semi-finished and finished products. They testify to the BIG PAY LOAD Capacity of the EC&M Type SA Magnet. Constant improvement by adaptation of new materials and advanced engineering practices not only keeps this capacity at a maximum but exhaustive research provides a quick source of information for the solution of any new handling problem.

Backed by years of experience, EC&M Lifting Magnets are the logical choice of industry for their magnetic material handling requirements. Put your material handling problems up to EC&M.

THE ELECTRIC CONTROLLER & MFG. CO.
CLEVELAND, OHIO

Good Lifts all day long such as this load of scrap pipe handled by a No. 5 Type SA Magnet of recent design result in better profits—provides an investment that pays for itself quickly.

EC&M LIFTING MAGNETS

Miles of

...Every Inch Under Automatic Time-Current Control

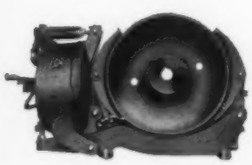
THE ELECTRIC CONTROLLER & MFG. CO.
E&M
CLEVELAND, OHIO

Steel in the Making

Again FORD selects EC&M Control

Over 100 EC&M TIME-CURRENT Controllers operate the mill auxiliary drives.

Over 100 EC&M Limit Switches provide proper operation of the auxiliary drives.



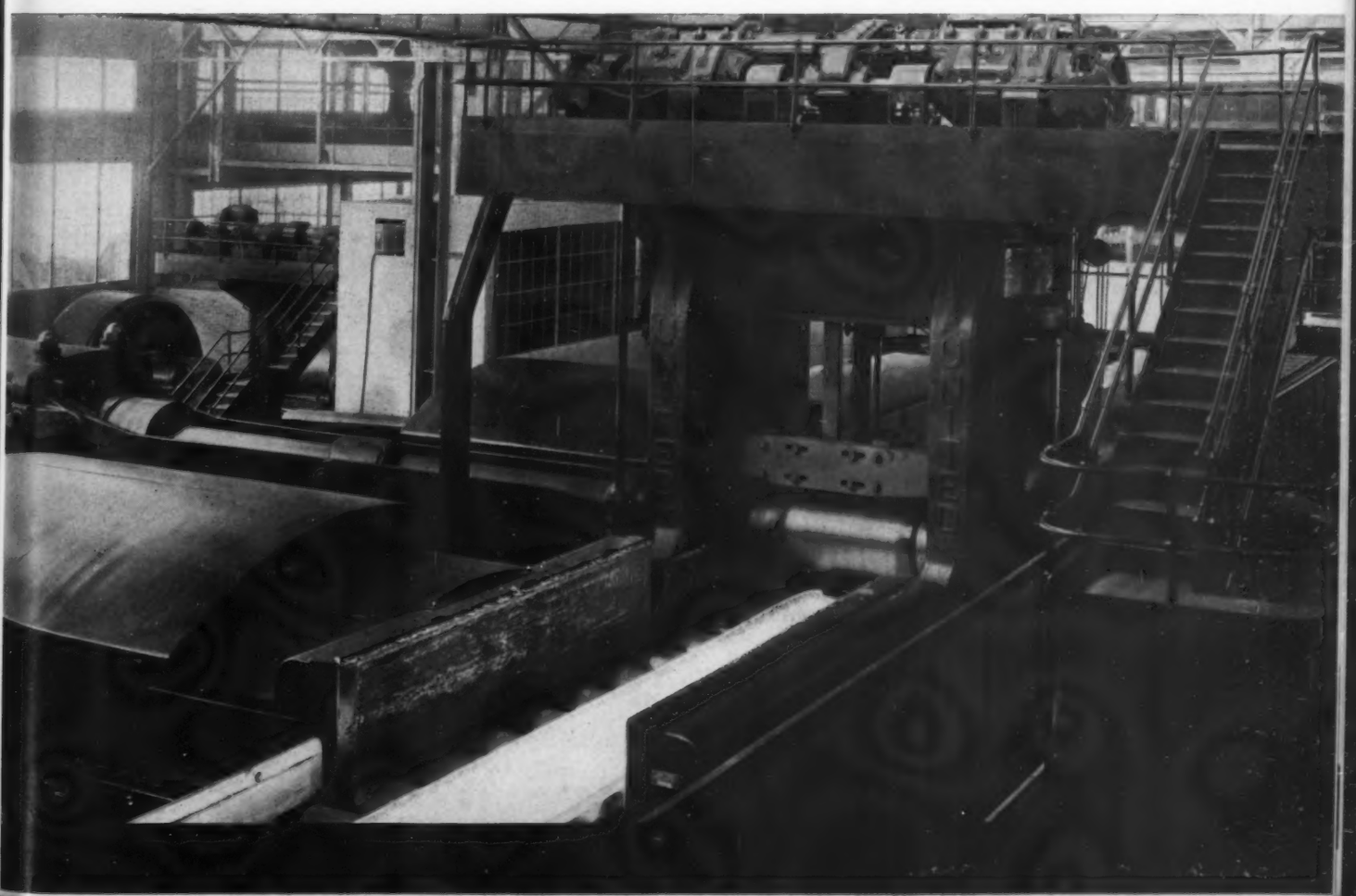
Nearly 200 EC&M Type WB Brakes are used throughout this mill.

WELL known for its high standards of quality, the Ford Motor Company uses only materials and equipment of dependable value. Guiding Ford's selection of EC&M equipment for the new blooming and hot mill installation at the River Rouge plant were many exacting tests and dependable performance proven from more than 20 year's experience with EC&M apparatus.

Now steel in the making glides swiftly and smoothly through this huge mill under automatic, fool-proof control . . . regulated from air-conditioned, enclosed pulpits...handled by drives, interlocked and protected by EC&M limit switches—all with a sequence of operation and an exactness of control that are almost superhuman.

Always built with an extra margin of safety and quality which insures uninterrupted service to the user, EC&M equipment is the logical choice of industries maintaining high standards.

THE ELECTRIC CONTROLLER & MFG. CO.
CLEVELAND, OHIO



EC&M CRANE CONTROL

ON THE FIRST POINT LOWERING —
All the Line Current passes through the Brake C

This exclusive feature insures
FAST BRAKE RELEASE

With this Crane Controller, the brake releases instantly. Instead of passing only a part of the line current through the brake on the first point lowering, the EC&M Wright Circuit is designed to allow all the current taken from the line to flow through the brake coil. The crane operator, no longer, need hesitate on the first step to give the brake an opportunity to release; instead, he can move his master controller immediately to any desired speed point. Improper brake adjustment has little effect on this quick release.

This improvement not only insures faster crane operation, but also provides greater accuracy and fewer movements when spotting heavy loads.

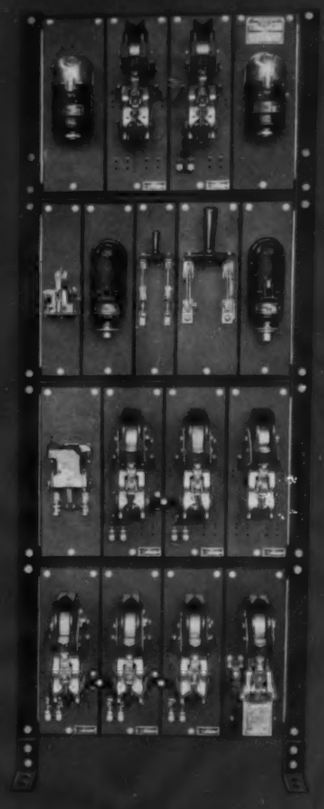
In addition to More Trips per Minute—the EC&M Bulletin 920 Wright Dynamic Lowering Circuit Controller permits a substantial reduction in power consumption, resulting in as much as a 30% saving in power consumed as compared with the previous type of dynamic lowering control.

Used in connection with this controller is the EC&M Type NT Bulletin 1182-1 Master Switch—sturdy, easily-operated, compact and of narrow width requiring a minimum space in the crane cab. Designed for upright or inverted mounting.

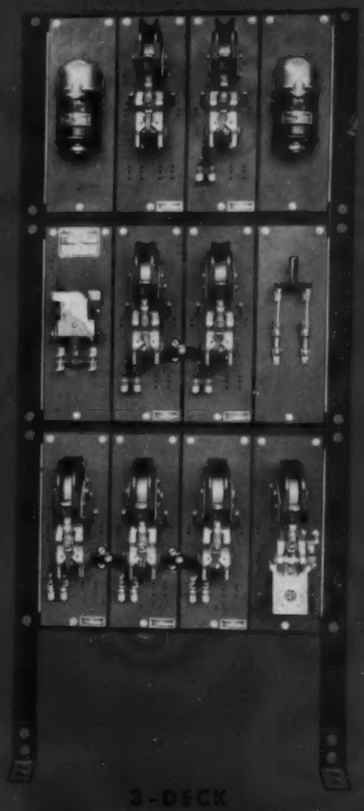
2, 3 or 4 Decks to suit Crane Headroom

The individual base construction of EC&M Magnetic Crane Controllers permits a wide latitude in controller-height to meet the requirements of mounting space available in cab or on runway. Single deck construction has been supplied for special cranes having extremely low headroom.

Specify EC&M Crane Control for Quick Brake Release and More Trips per Minute with Less Power Consumption



4-DECK WITH PROTECTION



3-DECK WITHOUT PROTECTION

The Wright Dynamic Lowering Circuit Hoist Controlle

Westinghouse Motors capitalize the value of PRECISION BEARINGS

The W-254 motors shown above—dual ventilated fan-cooled units—are built by Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa., and furnished to the Ford Motor Company. These—and many other Westinghouse motors in the Ford plant—are equipped with NORMA-HOFFMANN PRECISION BEARINGS. * * * * For 25 years, Westinghouse and Norma-Hoffman engineers have co-operated in many notable advances in the application of anti-friction bearings to electrical equipment for a wide range of service. * * * * Let our engineers likewise work with yours in modernizing your bearing applications. Write for the Catalog, listing 108 series and over 3000 sizes of PRECISION BEARINGS.

"NORMA-HOFFMANN"

PRECISION BALL, ROLLER AND THRUST BEARINGS

NORMA-HOFFMANN BEARINGS CORPN., STAMFORD, CONN. U.S.A.

New G-E 110,000-kw, 1200-lb steam turbine just installed in Powe Plant No. 1, side b side with a duplicate G-E turbine (1930) These are the larges industrial steam tur bines in the world

FROM POWERHOUSE

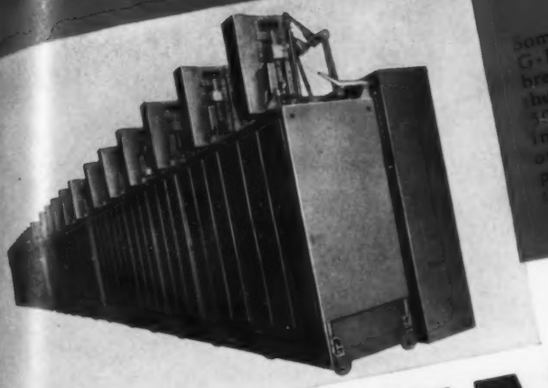
The largest induction motor in the world used for industrial drive, this 8000-hp G-E motor drives the 42 in. - 32 in. continuous blooming mill in the Ford Motor Co.'s steel plant

Giant G-E 7000-hp reversing motor drives the 44-inch blooming mill in the Ford plant

Close-up view of Ford's 56-inch tandem cold-strip mill, each stand driven by a G-E 1500-hp motor. Note the tensiometer, located between the mill stands, for automatically controlling the strip tension

Three G-E 1500-hp main-drive motors and 400-hp reel motor operating 3-stand cold-strip mill in the Rouge plant

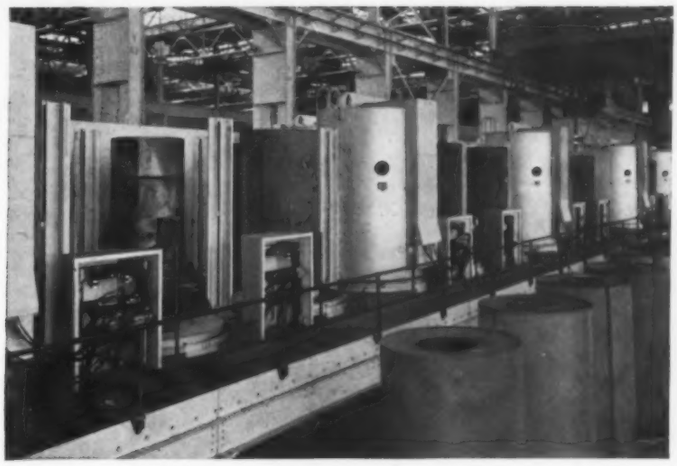
GENERAL



Some of Type FH G-E oil circuit breakers, of which there is a total of 39 units, enclosed in steel trucks, operating in the power house of the Rouge plant

TO FINAL PROCESSES

FORD



These 14 G-E bell-type electric furnaces in Ford's Rouge plant anneal wide steel strip in coils. Each furnace uniformly anneals 16 tons of strip per charge at a speed more than twice as fast as other methods

depends on

GENERAL ELECTRIC EQUIPMENT

And when we say "powerhouse," we mean POWER-HOUSE! Because that second G-E 110,000-kw steam turbine-generator installed in the Ford Motor Company's Rouge plant is the latest in modern turbine design, operating at 1200-lb pressure at a temperature of 900 F. These giants, the largest industrial steam turbines in the world, supply power for the huge General Electric motors that drive the Ford steel mill.

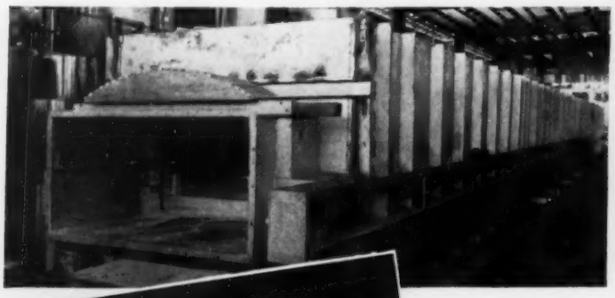
Other G-E apparatus combining to make this plant an efficient, smoothly working mill includes batteries of FH truck-mounted oil circuit breakers in the power-house; and the world's largest induction motor used in an industrial application—8000 hp, designed for 13,200 volts, the highest in industry—driving the 42-32-inch continuous blooming mill. Dozens of 1500-kw motor-generator sets supply 250-volt general-purpose power. The controlled-atmosphere, bell-type annealing furnaces —14 of them—are used for bright-annealing steel strip—lowering annealing costs, saving time, and uniformly annealing strip of superior quality. These furnaces occupy 50-per-cent less floor space than other types.

General Electric's experience in the design and manufacture of strip-mill drives gives you apparatus that permits continuous operation of your mill at high rates of production. The flexibility of the equipment, its co-ordination of design, ease of operation, and low maintenance requirements, save you both time and money.

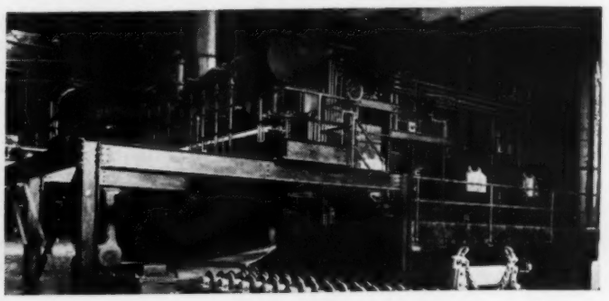
It will pay you to consult with General Electric when planning new mills or additions to your present plant. Our engineers are experienced in the electrical problems of steel-mill men. The nearest G-E office will gladly assist you.

Be sure to visit our exhibit at Convention Hall when you are in Detroit, September 22-25, and then see modern G-E steel-mill and powerhouse equipment in operation when you visit the Ford plant. General Electric Company, Schenectady, N. Y.

WORLD'S LARGEST continuous strip-annealing furnace . . . one of the new high-temperature units installed in the Rouge Plant modernization . . . is insulated with J-M Sil-O-Cel C-22 Brick and Sil-O-Cel Natural Brick. (*Furnace by Westinghouse.*)



NEW SLAB RE-HEATING FURNACE at Rouge Plant, insulated with J-M Superex, J-M Sil-O-Cel C-22 Brick and Sil-O-Cel Natural Brick . . . a combination insuring maximum insulating efficiency under the severest service conditions. (*Furnace by Rust.*)

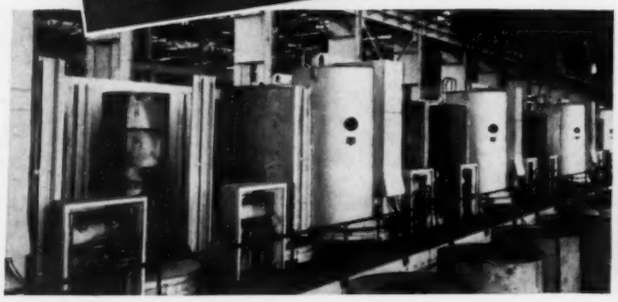


Johns-Manville
INDUSTRIAL INSULATIONS

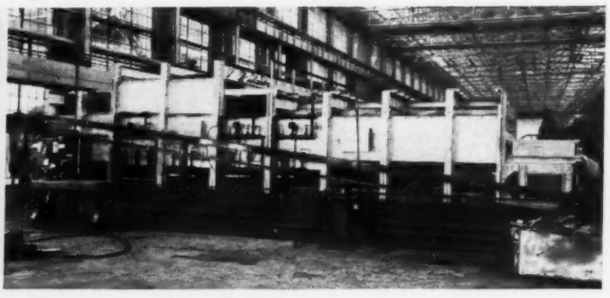
For every temperature condition from 400° F. below zero to 3000° F. above.

JM PRODUCTS

. . . Because Ford Profits begin at the Plant!



TWENTY-FIVE ELECTRIC FURNACES like this for annealing steel strip in the Rouge Plant are economically and effectively insulated on sides and tops with 7½-inch thickness of J-M Sil-O-Cel Coarse Powder. (*Furnaces by General Electric.*)



J-M SIL-O-CEL C-22 BRICK was used to insulate this Annealing Furnace in the Steel Mill Building. In C-22 Brick are combined all the characteristics essential to the ideal insulation for high temperatures. (*Furnace by Holcroft.*)

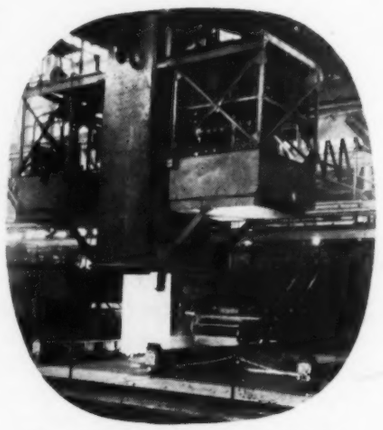
Efficiency of new heating equipment, installed as part of $35,000,000 Rouge Plant modernizing program, is safeguarded by use of many Johns-Manville Insulations

FORD believes profits should begin *at the plant* . . . hence this gigantic modernization program at River Rouge . . . with the old giving way to the new, the more efficient and economical.

To the installation of the latest heating equipment goes a substantial proportion of the $35,000,000 being spent. For this equipment is rightly expected, by virtue of the improved performance and reduced costs it can effect, to make Ford profits actually begin at the plant.

Highly significant, therefore, is the use of Johns-Manville Insulations on the high-temperature units pictured here, and on hot blast stoves, open hearths and other steel-mill equipment as well.

Their selection adds further proof to an established record for minimizing fuel costs, and for aiding in the control of temperatures, so that maximum operating efficiency and uniform product quality may be assured at all times. Johns-Manville, 22 East 40th Street, N. Y. C.



ON THIS SOAKING-PIT FURNACE, J-M Sil-O-Cel Natural Brick minimizes radiation losses and helps maintain high operating efficiency.

lew Switchgear by I-T-E for Rolling Mills

When steel mill after steel mill selects the new I-T-E circuit breakers and switchgear to protect main drives or auxiliaries, the reasons back of the choice must be of engineering interest. Full information is yours for the asking.

-T-E in the New Steel Mills of the Ford Motor Company

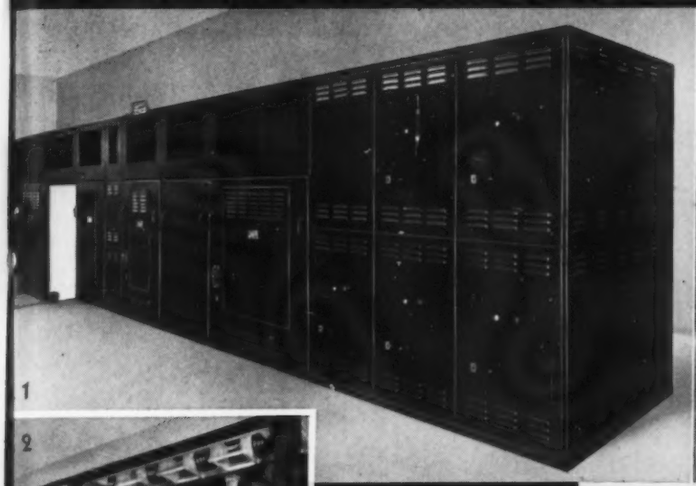


Fig. 1

Fig. 3

Fig. 2

440 volts a-c

600 volts d-c

250 volts d-c

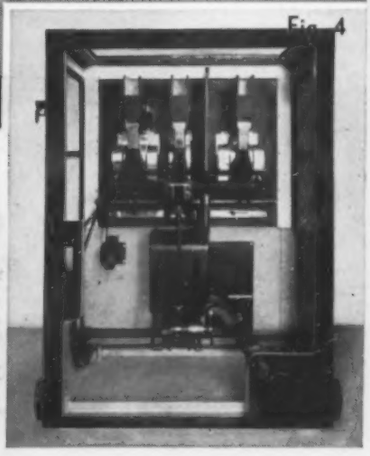


Fig. 4

Fig. 5

ont (Fig. 1) of steel-enclosed,) volt a-c switchboard, includ- high capacity main circuit akers of new removable truck e with improved racking-in chanism, and smaller feeder akers mounted on special ntographs. Aluminum chan- bus bar (Fig. 2) is segregated bonderized sheet steel enclo- e with improved ventilation.

Eighteen 3000-ampere feeder breakers and five 8000-ampere generator breakers (Fig. 3) completely bussed together in one steel enclosure. Solenoid operated truck type breaker (Fig. 4) includes features especially designed for steel-mill service—increased opening speed; high interrupting capacity; automatic reclosing; improved arcing contacts.

ne heavy-duty truck type circuit breakers (Fig. are rigidly interconnected (Fig. 6) by entirely lf-supporting bus run.

l details of the structure—choice of bus bar etal, mounting of insulators, arrangement of pansion joints—provide amply for the enor- ous short circuit forces encountered in steel- ill service.

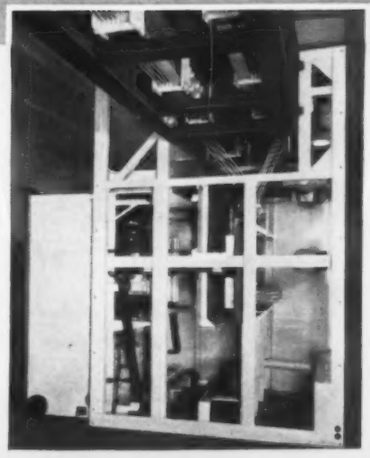
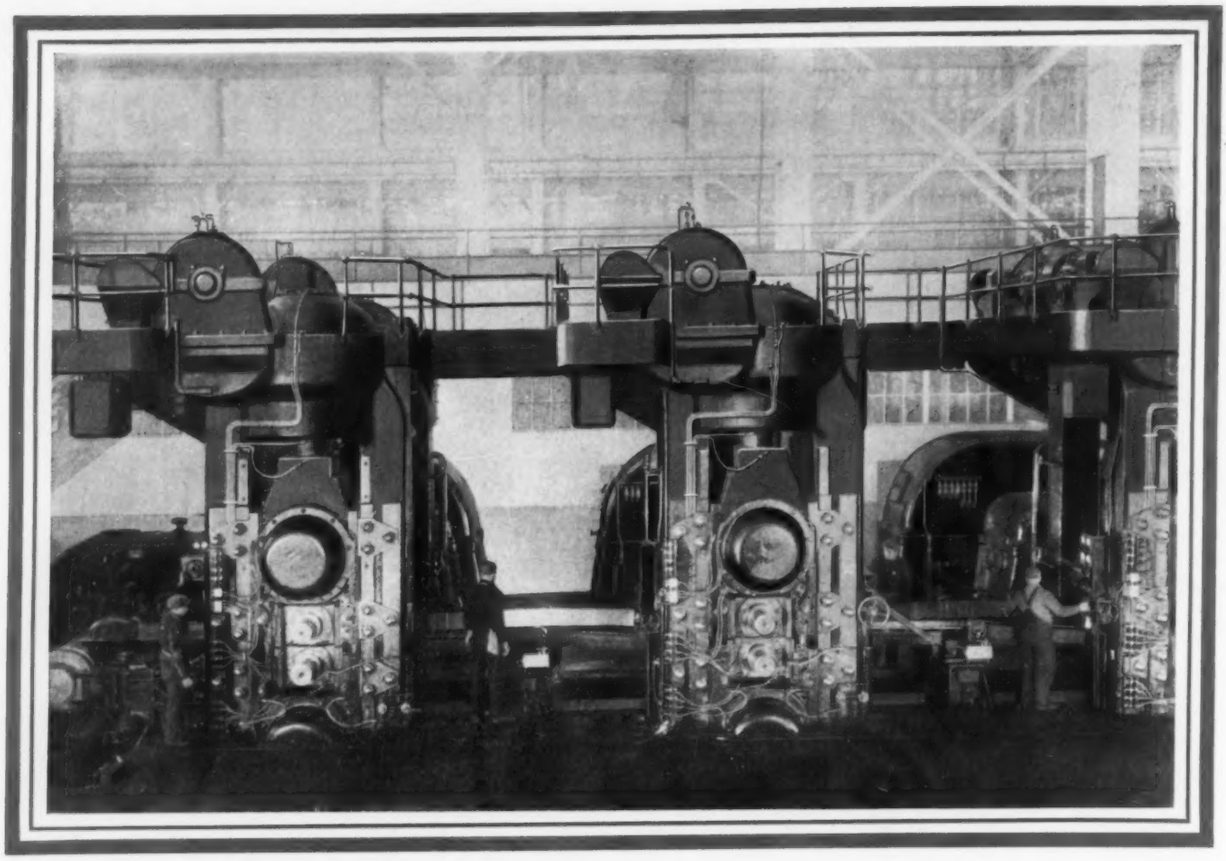


Fig. 6

A sixteen-page illustrated bulletin, detailing features of the new I-T-E steel-mill circuit breakers, is available. The information, though new, is backed by I.T.E. experience in furnishing protective equipment for main drives or auxiliaries in nearly all of the recently built steel mills.

Offices in Principal Cities

-T-E CIRCUIT BREAKER COMPANY, PHILADELPHIA, PA.



At the new Ford Cold Mill, one Farval Full Automatic System of Grease Lubrication is serving 420 points on the "United" 56 inch, 3 stand Tandem Mill—84 inch Reversing Mill and two 56 inch Tempering Mills—including all Tension Reels, etc.

• Thus, every bearing automatically receives its measured charge of lubricant at regular intervals. Quantity of lubricant delivered is adjustable and the frequency may be varied to suit the conditions, but the performance is always constant and positive. No bearings can receive too much, and none are missed.

Farval is also serving 847 additional bearings on conveyors and other miscellaneous equipment in the new Ford Mill. Farval can be installed on existing equipment without interfering with operations. We would be glad to have a Representative call at your convenience. The Farval Corporation, 3278 East 80th Street, Cleveland, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Manufacturers of Automotive and Industrial Worm Gearing.

FARVAL

CENTRALIZED SYSTEM OF LUBRICATION

Special Delivery to Every Bearing

SHEET AND STRIP STEEL FOR DEEP DRAWING

JOSEPH WINLOCK

By JOSEPH WINLOCK,
Chief Metallurgist
Edward G. Budd Manufacturing Co.
PHILADELPHIA, PA.

Abstract of paper to be presented before the A. I. & S. E. Convention, Detroit, September 22, 23, 24, 25, 1936.

▲ THERE IS no subject which more clearly illustrates the general observation that the "art precedes the Science" than the development of the deep drawing process. This is not only because the subject of plastic flow in metals is an extremely difficult one, but also because the unsymmetrical and complicated shape and contour of most stampings do not permit an analysis of the distribution and magnitude of the imposed stresses. A discussion of steel for deep drawing can be undertaken only with a full realization that the manner in which the draw is accomplished is, within limits, just as important to the success of the operation as the physical properties of the steel itself. The subject cannot, therefore, be approached from any one point of view. Theories—metallurgical and otherwise,—are of little value unless a knowledge of the practice gives some promise of their successful application. Such a situation very clearly demands the closest kind of cooperation between the metallurgists and the men in the steel mill and in the press shop. It is vitally necessary that each know the problems of the others in order to obtain satisfactory and consistent results.

The steel most widely used for deep drawing purposes is a plain carbon basic open hearth steel containing carbon under 0.10%; manganese under some 0.35% with low phosphorous and sulphur. There are two general methods for producing this steel: (1) the sheet method and (2) the strip method. The essential difference between the two methods is that in the strip method a large part and sometimes all of the rolling is done in one direction, whereas in the sheet method the ingot is first rolled to a sheet bar and then cross rolled to the approximate finished gauge.

The particular method used depends upon the equipment available in each particular mill. Whatever method is used, the general outline of procedure consists in a series of hot rollings, cold rollings, annealing operations and pickling operations. The number and sequence of these operations depend in part, also, upon the deep drawing qualities and the surface qualities needed or desired in the finished product.

The first important operation after the making of the steel and the casting of the ingot is hot rolling. If the temperature at which this rolling is carried out is above some 1100 deg. F., enough residual heat may remain in the steel after rolling to prevent the occurrence of distorted grains in the metal after it has reached room temperature. When steel is hot rolled to the lighter gauges, the finishing temperatures on the hot mill are usually so low that a considerable amount of the deformation is actually "cold" work. Low finishing temperatures on the hot mill are often necessary, however, to obtain good surface qualities.

Mechanical deformation of iron and steel at low temperatures greatly affects the physical properties of metals: The elastic limit, tensile strength, and hardness being increased while the ductility as represented by the per cent elongated and percentage reduction of area is decreased. Evidences of reductions by cold rolling even as large as 15.0% cannot be detected under the microscope, but the physical properties are, nevertheless, deeply affected by reductions even as low as 0.5 percent.

Sheet steel is cold rolled primarily to obtain good surface qualities, uniform gauge, and flatness. The reductions in thickness are seldom more than 3 per cent. Strip steel is cold rolled for the same reasons, with the additional purpose of rolling to the lighter gauges. In the case of strip steel, the reductions effected by cold rolling are usually 20 per cent or more and often are as high as 60 per cent. Different amounts of cold rolling effect deeply the physical properties of the steel even after a subsequent annealing operation. For example, if the reductions by cold rolling are small, some 3-5 per cent, the grain size after a low temperature anneal will be extremely large. A steel having a large grain size will produce an objectionally "coarse" surface on the stamping after the drawing operation and is more susceptible to "Stead's" brittleness. On the other hand, large reductions by cold rolling tend to produce a very small grain size which renders the steel so susceptible to the production of "stretcher strains" in the finished stamping (peculiar lines of depressions or elevations which occur in drawing annealed steel) that the removal of these presents one of the greatest difficulties encountered in the deep draw-

ing of steel. Cold rolling as a final operation in the mill will prevent the occurrence of stretcher strains, but the ductility of the steel is often seriously affected and the tendency to "age" (spontaneous decrease in ductility) is increased. Special roller levelers have been designed to help relieve this situation.

Since the deep drawing process is essentially a cold working process, a knowledge of its effect on the metal while being formed is of utmost importance also. Residual elasticity in the metal after a given amount of draw ("spring back"), for example, necessitates certain precautions in the designing of the dies for deep drawing. Again, the stretching of a blanked edge often produces tears in the metal due primarily to the cold working of the steel in the blanking operation.

F. J. HARLOW

GAS DISTRIBUTION AT FORD PLANT

By F. J. HARLOW, Manager
Industrial Division
Philgas Department
Phillips Petroleum Co.
DETROIT, MICHIGAN

Abstract of paper to be presented before the A. I. & S. E. Convention, Detroit, September 22, 23, 24, 25, 1936.

▲ MR. AVERAGE CITIZEN invariably spends considerable time and study on the relative merits of the various makes of automobiles before making a choice. However, when his selection is made, he comes into the market with an insistent demand for the desired car immediately.

This buying tendency, coupled with a desire to own the latest model, has created very high peaks in production in the automobile manufacturing industry.

During these peaks, every source for the supply of the necessary raw materials and parts must exert diligent effort to meet the demand.

Heat is an extremely important factor in the production of the modern automobile. Proper and controlled application of heat is responsible for many various service characteristics of steel and the other metals of which the major portion of the car is composed. Grain structure, toughness, ductility, and hardness each in its proper place, are all products of controlled heat application. The glass in the windows, lamps and windshield, and even the tires, all depend on heat for their most desirable qualities.

Therefore, as heat is such an important tool of production, various types of fuel should also be available, each properly applied, to meet the demand. Quality of each part must be maintained to the high standard required at all times.

In the modern automobile plant many types of fuel can be and are used:

Coal for boiler fuel to furnish power as electricity and compressed air. Also for steam heating of shops and offices and for washers, dryers and plating tanks.

Electricity is used as a furnace fuel for heat-treating and as an electric furnace smelting fuel.

Oil for forging, normalizing, drawing and other heat-treating operations where scaling is not objectionable. Oil is also sometimes used as boiler fuel.

Tar is also used much the same as oil.

Gas for high quality heat-treating under close control, both as to atmosphere and temperature. Gas is frequently used as an atmosphere in certain furnaces where electricity is used as a heating medium. Gas is also coming into universal use for japan, laquer and paint drying ovens of the direct fired type.

Gas is used for glass melting, firing stoves on blast furnaces, under-diring coke ovens and direct heating of air for space heating and "make-up" air to spray booths.

Ford Motor Company has all of those fuels available.

Considerable time and study at River Rouge Plant is expended on the inherent respective characteristics of the various fuels, so as to allot the proper heating medium to each production operation to maintain the quality desired in each part.

At Ford Motor Company main plant at River Rouge, this problem of fuel supply is of far greater importance than in most automobile plants. The reason being that a great deal of raw material such as steel, glass and other basic products are produced at the River Rouge Plant. The Steel Mill and Glass Plant each require large quantities of fuel for their operation alone. The various quantities consumed at the River Rouge Plant per average day are as follows:

Coal—Boiler House	2,000 Tons per day
Coke Ovens	3,000 Tons per day
Oil—Forge and Steel Mill	80,000 Gallons per day
Coal Tar	40,000 Gallons per day

500 B.t.u. Coke Oven Gas	54,000,000 Cubic feet per day
100 B.t.u. Blast Furnace Gas	564,480,000 Cubic feet per day
3200 B.t.u. Liquefied Petroleum Gas, (Butane)	640,000 Cubic feet per day

However as the gas is produced from the coal used at the coke ovens, the coke oven coal consumption can be neglected in the total.

As this paper is to discuss the gas distribution and requirements for regular production, it might be well to pause and consider the gases required as a single gas. For this interesting comparison, let us choose the 500 B.t.u. coke oven gas, as this most nearly conforms to the usual public utility standard manufactured gas of 530 B.t.u.

500 B.t.u. Coke Oven Gas	54,000,000 Cubic feet
3200 B.t.u. Butane at 500 B.t.u.	4,096,000 Cubic feet
100 B.t.u. Blast Furnace Gas at 500 B.t.u.	32,256,000 Cubic feet
TOTAL Gas Required at 500 B.t.u. per cu. ft.	90,352,000 Cubic feet

The average consumption per meter in domestic service is usually considered as 2500 cubic feet of 530 B.t.u. gas per month. This would require 2650 cubic feet of 530 B.t.u. gas. On this basis Ford Motor Company's River Rouge Plant uses each day enough gas to supply 1,020,000 average American families, or the domestic consumption of 4,794,000 people, at 4.7 persons per family.

According to available 1934 statistics Detroit and environs consists of the city of Detroit, seven adjacent towns, twelve villages and the suburban townships, used during the maximum days consumption seventy-six million, three hundred ninety one thousand cubic feet (76,391,000 cu. ft.) of 530 B.t.u. gas.

The combined demand of 365,482 domestic and house-heating, 13,970 commercial (hotels, restaurants, etc.) and 671 Industrial plant consumers for gas are served in the above territory.

While at the Ford Motor Company the River Rouge Plant alone uses an equivalent of 85,000,000 cubic feet of this 530 B.t.u. gas per average day.

To store and maintain continuity of service to Detroit, a storage holder capacity of approximately 58,000,000 cubic feet of gas is provided.

The gas storage capacity at River Rouge when completed will consist of:—

Main Gas Holder	Capacity	10,000,000 Cubic feet
Liquefied Petroleum Gas Tanks	Capacity	50,000,000 Cubic feet
Process Holder	Capacity	200,000 Cubic feet
TOTAL		60,200,000 Cubic feet

The facilities provided at the River Rouge Plant to meet this enormous demand for gas in the various departments are very elaborate.

The distribution of gas at River Rouge Plant is handled on a very different basis than that of the public utilities.

The public utility furnishes gas to its customers within very definite thermal value limitations imposed by franchise specifications usually under state public service commission control.

At River Rouge the gas is served to the plant in general, based on constant combustion characteristics, rather than on thermal value. To accomplish this a 500 B.t.u. coke oven gas is taken as a standard the other available gases are blended to augment this coke oven gas supply based wholly on the ability of the blend to function interchangeably with this base gas in any given appliance with equal efficiency at a constant distribution line pressure. It has long been recognized that gas density is also an important function in certain departmental operations. In the Glass Plant the liquefied petroleum gases are used undiluted because these dense, high thermal value gases lend themselves very well to glass melting and planing. In the heat treat department in certain controlled atmosphere appliance such as gas carlining furnaces, the atmosphere is maintained by the use of liquified petroleum gas and is here restricted to propane.

All in all many problems in gas distribution have been encountered and the methods of solution are interesting.

In the solution of these problems, safety was always held "First" and all precautions were taken to make the whole system as safe as is possible.

STUDY OF BLAST FURNACE CHARGING

By GORDON FOX, Vice President
Freyn Engineering Co.
CHICAGO, ILLINOIS

Abstract of paper to be presented before the A. I. & S. E. Convention, Detroit, September 22, 23, 24, 25, 1936.

▲ THIS DISCUSSION does not pretend to deal with all phases of blast furnace charging. It is concerned only with the mechanics of material handling to meet more or less prescribed specifications.

The remarks refer principally to a study which was made by Gipromez as a phase of the design of the 1000-ton standard blast furnace which now finds a place in most of the new Russian steel plants.

The charging equipment determined upon for the initial blast furnaces of this design include:

Bins arranged in a double row with two central coke bins. The coke bins are provided with coke screens and weighing hoppers for automatic weighing and charging of coke. The other bins are provided with roller type gates operated from the scale car. The latter is of the two-compartment type.

Skip tubs of large capacity are of bail type and are operated at moderate speed by a single-drum hoist

GORDON FOX

driven by a compound-wound motor supplied from the plant direct-current system.

Bells are of suspended type, not counterweighted. They are actuated by low pressure pneumatic cylinders located in the skip engine house under the skip incline. The valves controlling these cylinders are electrically operated. The small bell hopper is arranged for rotation.

All charging operations are coordinated and interlocked by a full-automatic electric charging control system.

A number of studies were made to determine the time required by the scale car for its movements and charging functions. Some of these studies are presented in chart form.

Further studies and charts were made which depict the time requirements for coke weighing and charging, for skip, hopper and bell movements. These charts are of interest particularly in that they depict the relationships between the movements of the various elements of the charging system, they indicate what factors introduce limitations, and they demonstrate the importance of coordination of movements as a means of securing maximum results.

The diagrams included in this discussion indicate that the charging equipment as described, with the charging methods proposed, has a potential capacity to burden the furnace for a production substantially in excess of its nominal rating. Dependent upon the charging round employed and the coke ratio per ton of iron, the charging operations incident to the production of 1,000 tons of iron necessitate that charging operations be carried on from about 50 per cent to about 85 per cent of the total time. The limitations in charging capacity are found to lie principally in the scale car movements. Only in a lesser degree is the capacity influenced by the skip-hoist movements and by the movements of the furnace top mechanisms. The time requirements of the latter mechanisms are seen to be inimical to any substantial reduction in the time of movement of the skip hoist resulting from increase in its operating speed.

A tabulation of results which might be obtained with a higher speed skip hoist indicates that for the conditions in this case, a substantial increase in the speed of the skip hoist does not lead to a proportionate increase in charging capacity. It is further indicated that a substantial increase in speed of the skip hoist would involve a more than proportionate increase in the cost of electric drive equipment in addition to increased cost of other elements of the furnace construcion.

In view of the adequacy of charging capacity afforded by moderate-speed equipment, as indicated by the several studies made, it was decided that, for this design, the use of high speeds for any of the charging mechanisms was unnecessary and could not be justified. These mechanisms are large and involve heavy masses. Their operation is of start and stop character. Inertia and kinetic energy are important considerations. Smoother, simpler operation, less impact stresses, lower power consumption and less maintenance cost are inherent in the slower speed mechanisms. The use of moderately speeded mechanisms, well co-ordinated, is preferable to the use of high speeds which may be necessitated by poor coordination.

The use of automatic coke weighing and full-automatic charging was decided upon in order to obtain the best possible coordination of equipment movements; to insure accuracy in maintaining charging schedules; to minimize delays, messes and annoyance caused by human errors, to charge definite coke weights, and to minimize costs.

Bell suspension of the non-counterweighted type was selected in order to avoid heavy counterweights, particularly on top of the furnace, to minimize the liklihood of damage resulting from an explosion between bells, and to permit the use of a simple yet effective type of bell operation.

FUEL ECONOMY

By MARTIN J. CONWAY

A short review of this pertinent steel mill problem

▲ WITH THE steel industry running at the rate of approximately 90 per cent of the 1929 production figures, a few minutes pause to review past progress may act as a stimulant to present and future efforts.

The natural increased demand for steel has in turn stimulated contributary industries and foremost of these industries to benefit are the suppliers of fuel and power: coal, coke, gas, oil, and electricity.

Since the commencement of business improvement in early 1932, there has been a steady increase in the unit fuel prices and the steel industry has had difficulty trying to maintain uniform fuel costs per unit of steel

MARTIN J. CONWAY

production in face of the increasing costs of the fuel units.

That these attempts have not been entirely futile is seen by the fact that the fuel units per unit of steel production have been steadily decreasing during the past ten years, and noticeably so during the past five years.

It is estimated that due to the substitution of natural gas, oil, blast furnace, and coke oven gas, the reduction in the use of producer gas per ton of steel ingots produced is 20 per cent less today than it was in 1928; the large increase of blast furnace gas and coke gas made available because of greater economies in process fuel consumption has, in individual plants, effected economies of substantially 25 per cent, and has contributed to the 12 per cent decrease in fuel consumption per ton for the industry which has taken place during the past 10 years.

Of the 5,000 gas producers installed in the United States, only about one-half of them are in use due to the producer gas being substituted by higher form fuels.

In 1915 the production of by product coke was a little more than 14 million net tons or 33.8 per cent of all coke produced. In 1935 the production of by product coke was over 34 million net tons, or substantially 97 per cent of all coke produced and after allowing sufficient gas for the firing of the coke ovens and loss in operations, 165 billion cubic feet was supplied to utility systems and 181 billion cubic feet was used in industrial process work chiefly in the steel industry.

In 1929, the maximum year for pig iron production, it is estimated that 2,900 billion cubic feet of blast furnace gas having an average heating value of 95 B.t.u. per cubic foot was available for service other than preheating the air in the stoves and for blowing engine power. In 1935 the amount available was 1,500 billion cubic feet, yet a greater proportion was used for process heating, raw coal and coke breeze being in greater demand as steam raising fuel, thereby reserving this gaseous fuel to be utilized where they are more efficient to use.

The enriching of blast furnace gas to make it more desirable as a process fuel has meant much in plant fuel economy programs in the past few years. Coke oven gas has been the chief enriching agent where available, and more recently the addition of liquid petroleum gases to blast furnace gas, producing a combined gas having from 500 to 550 B.t.u. per cubic foot has greatly added to the possibilities of utilization of blast furnace gas for all kinds of process heating work. This coupled with the fact that gas production is more or less coincident with process consumption demand.

These higher form fuel requirements have contributed impetus to the instrument and control industry who in turn have helped to maintain economies, once conceived.

Simply designed and easily maintained efficient heat recovery devices, covering the full temperature range, from waste heat boilers to refractory recuperators are now engaging the attention of steel plant engineers, and will play no small part in the fuel economies of the future.

TREND IN REFRACTORIES APPLICATION IN THE STEEL PLANT

By A. V. LEUN, Refractory Engr.
Bethlehem Steel Company,
BETHLEHEM, PENNSYLVANIA

Abstract of paper to be presented before the A. I. & S. E. Convention, Detroit, September 22, 23, 24, 25, 1936.

▲ REFRACTORIES, either raw or processed, is one of the most important items involved in the production of steel and its allied products.

In recent years, many worth while improvements have been made both in the manufacture and application of refractories employed in the production of steel. These improvements were necessitated because of (1) The greater service and temperature imposed on the refractories, (2) The growth of alloy steel development, (3) The continued drive for clean steels, (4) The necessity for lower refractories cost and (5) The necessity for lower fuel consumption per ton of steel.

With the advent of more rigid pouring practice together with hotter and longer pouring, trouble was encountered in excessive erosion of the nozzles, resulting in a poor rate of pour, melting away of the sleeves, burning off of the rod at the stopper head, sticking of the head to the nozzle seat and excessive washing of the runner brick.

The manufacturers of ladle refractories upon being appraised of this situation immediately took steps to correct the condition and today our ladle refractories are very superior to those formerly used.

The insulation of open hearth furnaces, especially

A. V. LEUN

above the floor line is comparatively young. Ten years ago an almost unanimous majority would have emphatically stated that an insulated furnace would melt down rapidly. Today many furnaces throughout the country are completely insulated and besides obtaining lowered fuel cost, the roof life has been increased several hundred heats, due to its greater refinement.

The proper application of insulation is most important as is the operation of the furnace after insulation is applied. Care must be taken to see that the hot face temperature of the brick does not exceed that temperature before being insulated.

The manufacture of basic refractories, namely, chrome and magnesite brick, has been greatly improved. By means of heat and chemical treatment, the load carrying capacity and spalling resistance of chrome brick have been raised to such an extent as to make the application of chrome brick greater and more diversified.

Today both unburned chrome and magnesite brick are on the market. These brick show only negligible volume change at working temperatures.

In the past, insulating brick have been considered only in the light of back up brick for fireclay or other refractory brick, decreasing the heat loss through such walls to the surrounding air but increasing the heat content of the walls.

Today light weight fireclay brick are firmly established in the industry. These brick besides having fairly low heat conductivity values also possess suitable refractoriness to allow for their use in actual contact with the furnace temperature.

The application of these light weight fireclay brick will effect high fuel savings especially in those furnaces whose operation is intermittent.

Because of the demand for greater production, the application of external insulation, the use of higher working temperatures and the continued drive for cleaner steels, the brick manufacturers have been obliged to produce a fireclay brick possessing greater refractoriness than first quality brick. These brick, are capable of standing temperatures up to 200°F higher than first quality clay brick. They have application in such places as; forge furnaces, kilns, blast furnace stoves, boilers, open hearth checkers, etc.

Recently de-aired clay brick have been introduced to the trade by the refractories industry. The use of a vacuum during the forming of brick affects only the density of the brick. By the de-airing, part of the entrapped air is removed, allowing for a greater weight of refractory per brick. This elimination of air and slight increase in the weight of the brick tends toward higher heat conductivity and better abrasion resistance.

Power-pressed silica brick as manufactured are of truer dimension and practically free from warping the length of the brick. The application of silica brick to an open hearth roof necessitates the use of brick of the most uniform size and dimension. When employing hand or drop molded brick, some of these brick being slightly bowed, will crack off during the heating up of the roof and drop out. The use of power pressed silica brick will go far towards correcting this situation.

RECUPERATORS FOR CONTINUOUS SLAB HEATING FURNACES

By W. H. FITCH, Manager
Recuperator Department
Carborundum Company
PERTH AMBOY, N. J.

Abstract of paper to be presented before the A. I. & S. E. Convention, Detroit, September 22, 23, 24, 25, 1936.

▲ THE PERSISTENCY with which furnace builders and operators have clung to the recuperative principle for the preheating of air for combustion of fuel, and their search for better recuperator design and efficiency is quite evident judged by the great number of trial installations that have been made during the past several years.

A number of the furnaces of the regenerative type have been rebuilt using silicon carbide tubular recuperators, the checkers and reversing mechanism being completely eliminated. There is sufficient evidence to justify the statement that the recuperative principle is more effective in these applications than were the regenerators previously used. On the strength of this it is reasonable to suppose that greatly improved results can be gained by applying the recuperative principle to furnaces of larger capacity. Unquestionably this opinion is growing among steel men who seriously questioned such claims a few years ago.

The use of the recuperative principle affords firing in one direction continuously and a constant flow of

heat, thereby increasing the rate of furnace production to the maximum—requires the minimum amount of space for building, and costs no more to build with super-refractories than a regenerator system for a given amount of work to be done. In the case of an open hearth furnace rebuild below the floor the air chambers are sufficient to house the tubes that are necessary. With hot producer gas fuel being used, the gas would be conducted direct to the furnace gas ports. Any benefits due to increase in temperature of the gas as a result of passing it through checkers is offset by the cost of the installation and its maintenance.

The building of a recuperator to give satisfactory performance continuously requires great care. Materials that are best suited for the making of the various parts should be carefully selected and then assembled in a practical manner. A great variety of operating conditions must be given consideration if the attempt is made to apply successfully a given recuperator design to different types of furnaces used in the several industries. Particles that are found suspended in the waste gases in one case do not exist in another. Some of these constituents are more harmful and destructive than others to the heat transfer elements of a recuperator. Wide variation of temperature of waste gases is found. Working cycles of furnaces vary from eight hours to several thousand. Erosion, contraction and expansion, surface accumulation and ease of cleaning and making replacements must be considered. The life of the heat transmitting walls would be shorter in an open hearth than in a continuous reheating furnace. Again the life in a steel melting furnace that runs constantly for many weeks at a time would be greater than in an air furnace operating ten hours out of twenty-four hours. Speed at which the air temperature can be raised and steadiness which can be maintained are factors.

It is apparent that a recuperator should be designed to be completely accessible so that by renewing worn parts a high state of efficiency can be maintained for the recuperator as a whole over a long period of time.

Of all devices that have been used as heat transfer elements in recuperators applied to industrial furnaces in general, silicon carbide tubes have shown outstanding results. In fact, I know of no other maiterial that could be used in many cases.

Careful study of the following is merited by those planning the use of recuperator equipment.

High Thermal Conductivity—"Carbomex", a bonded silicon carbide refractory, has a thermal ronductivity approximately ten times that of fireclay refractories, the curve being a straight line between 105.5 B.T.U. per hour per sq. ft. per inch of thickness per degree Fahrenheit difference in temperature at 1100° F. and 112.5 B.T.U. at 2900° F.

Great Strength—It has an average modulus of rupture of approximately 900 lbs. per sq. in. at a temperature of 1350° C. (2462° F.). Its compressive strength at this temperature is in excess of 10,000 lbs. per sq. in.

Freedom From Spalling—It has never failed through spalling in any industrial application. It has a much lower spalling tendency than other commercial refractories. In a standard spalling test it shows no loss

W. H. FITCH

after one hundred coolings as compared with 4% loss after forty coolings for Grade A fireclay.

The silicon carbide tubular recuperator has been applied to about seventy industrial furnaces, in six basic industries including several continuous steel slab and billet reheating furnaces. Additional installations of the latter character are being made at the present time. Incidentally, the total yearly rated capacity of these continuous furnaces, equipped with this heat reclaimer, is over 3.5 million tons of steel.

Several recuperator arrangements have been applied to continuous reheating furnaces due to the variation in physical conditions surrounding the furnaces and the quantity and kind of fuel burned per unit of time.

The first continuous reheating strip mill furnace built with a silicon carbide tubular recuperator is at the Ford Motor Company's plant at Dearborn, Michigan. Two furnaces were installed originally. No. 1 furnace was equipped with the tubular recuperator and No. 2 with a fireclay tile recuperator. Each was designed to heat thirty tons per hour on the basis of steel entering at atmospheric temperature and sixty tons per hour with steel charged at 1400° F. approximately.

In case of the tubular recuperator, 376 tubes were installed, arranged in two banks of 188 tubes each.

Corebusters are used to increase the inside convection area as well as increase the rate of heat transfer.

An important detail of design is the wall blocks. It is necessary to hold the assembly tight enough to prevent leakage at the pressures employed and at the same time permit the movement of the tubes. The desired results are obtained by grinding all contacting surfaces of the blocks and having them recessed or undercut to permit sealing the block joints as well as the tube ends by the use of a cement that is resilient under the working conditions.

An interesting feature of the design was that either recuperator could be replaced by the other type if such a procedure should prove desirable after the furnaces had been run for a sufficient length of time to afford a comparison of results.

The distribution of the heat of the waste gases in the recuperator is noteworthy. Viewing the tubes in vertical rows, beginning at the hottest row, the color of all tubes in each row is exceptionally uniform. The

color diminishes progressively until it disappears in the last few rows where the waste gases leave the recuperator.

Referring to heat transfer, with reference to recuperators, it is known that high air velocities are essential for the maximum amount of work to be done per unit of heating surface, but it has been said this condition unfortunately cannot be maintained in a refractory type of recuperator due to leakage. This statement makes an examination of the following operating conditions of the tubular recuperator of interest.

The air velocity and leakage problem formed the basis of a large amount of experimental work in our own shops. A test for leakage of air through a tube terminal wall, 75 sq. ft. containing 105 tubes, was made daily extending over several weeks, in which the temperature of the gas side was raised to 2400° F. The total loss of air at 1″ water pressure was 15 cu. ft. per minute.

Improved Design for 50-Ton Furnace

After designing several tubular recuperators for this service and studying operating results we have decided that a much smaller recuperator capacity than we originally recommended will do the work. Three hundred sixty 52″ long tubes with 2″ corebusters, divided in two sections of 180 tubes—each section arranged for two passes for air as illustrated, will be satisfactory for heating air to 750° F. with a fifty ton furnace.

This construction has the advantages of shortening the length of travel of the waste gases between the furnace outlet ports and the heat transfer elements—provides for the minimum of resistance to flow of waste gases through the recuperator zone—the upward flow of air as it passes from one bank of tubes to the other—permits placing the recuperator under the furnace at a point where the head room is greatest—reduces the length of space required for a recuperator and correspondingly lowers the cost of foundations to a minimum.

HEAT TREATING ALLOY BAR STOCK IN ELECTRIC FURNACES

By DR. MARCUS A. GROSSMANN
Director of Research
Carnegie-Illinois Steel Corp.
CHICAGO, ILLINOIS

Abstract of paper to be presented before the A. I. & S. E. Convention, Detroit, September 22, 23, 24, 25, 1936.

▲ THE PAPER is to take the form of a brief description of the equipment, followed by motion pictures of the equipment in actual operation.

MARCUS A. GROSSMANN

The equipment consists in essence of two bell-type electric heating furnaces and one quenching tank, all large enough to handle bars up to 30 feet in length. The outstanding feature of the equipment is the uniformity obtained in the heat-treating operations. This uniformity is promoted on the one hand by the design of the furnaces for uniform heating, and on the other hand by the automatic timing of the crane motion and of the quenching operation.

Uniformity in heating is promoted by the design of the bell-type furnaces. Each furnace consists of a car bottom, upon which a rectangular bell-type heating chamber descends when the furnace is in use. The car bottom is so arranged that the load of bars rests on elevated racks of heat-resistant alloy. The bell-type heating chamber descends and rests on this car, the whole being closed by an oil or sand seal. The heating elements are in the bell-type cover, and are so placed on the sides and roof as to give uniform heating of the load.

When the load is ready for quenching and tempering, these operations are then carried out almost entirely automatically. That is to say, the bell is raised and the subsequent operations are carried out automatically by proper setting of the electrical equipment: Pulling out the furnace car, raising the load by means of the crane, moving the crane over the quenching tank, quenching the steel for a predetermined number of seconds or minutes and transferring the quenched steel to the car of the tempering furnace. The tempering furnace has already been brought to temperature, the car is moved into the furnace, the bell is lowered and the tempering operation is carried out immediately.

The above operations make full use of the automatic features in this equipment. Other operations such as annealing or normalizing are of course simpler and the manipulation of the equipment is carried out in a correspondingly simpler manner.

The motion pictures will show the loading onto the cars, the placing of cars and lowering the bell, the removal of cars and the quenching and normalizing operations.

AUTOMATIC CONTROL IN OPEN HEARTH FURNACES

By A. F. SPITZGLASS, Vice President
Republic Flow Meters Company
CHICAGO, ILLINOIS

A. F. SPITZGLASS

Abstract of paper to be presented before the A. I. & S. E. Convention, Detroit, September 22, 23, 24, 25, 1936.

▲ THE CONTROL of an open hearth furnace presents a very finely interwoven pattern of functions, reacting on each other in such a way that every function has a bearing on all the others. The actual operations involved, however, are relatively few in number, and consequently each operation requires a high degree of functional "intelligence" in order to blend properly into the entire pattern. Much thought goes into each individual setting and there is consequent justification in assuring permanency of the setting.

The elements of the problem are presented in the order of their importance to the operator.

1. *Production.* Transferring the heat to the charge so as to melt and refine the heat as fast as possible is the first concern of the open hearth operator. This involves considerations such as (a) maximum yield per unit time and per unit charge compatible with quality desired; (b) obtaining the highest possible flame temperature; (c) spreading the flame uniformly over the bath; (d) proper atmospher to assure correct reaction and maximum flame temperature, and ready means of suiting the atmosphere to the constantly changing requirements of the heat.

2. *Furnace Life.* The length of the campaign involves such factors as (a) complete combustion of the fuel; (b) keeping the roof temperature within the limitations imposed by the refractories; (c) low velocities in the flue passages; (d) keeping furnace and flue pressures as nearly atmospheric as possible.

3. *Operation of Furnace During Heat.* There are many adjustments required during the progress of the heat and good control must embody mechanism for performing these adjustments. Thus, (a) fuel rate should be easily adjusted to a variety of controlled values; (b) reversing the furnace (whether manual or automatic) must be accomplished in the minimum time and with the minimum of disturbance to atmospheric conditions and rate of fuel feed; (c) period of lime boil require ready adjustment of excess air.

4. *Fuel Economy.* While this is a primary consideration of the fuel engineer, it is secondary to the production problems listed above in the overall operating picture. For fuel economy (a) high flame temperature, again, is of utmost importance; (b) air infiltration must be minimized; (c) fuel and air must be properly proportioned in order to maintain the high flame temperature and to reduce sensible heat loss in the gases or loss due to unburned fuel.

5. *Mechanics of Control.* Here we run into a great variety of operating conditions and mechanisms among which the following will be considered more fully in this paper. Sensitivity required due to (a) extremely low pressures and vacuums in the furnace; (b) damper mechanism, slide dampers; (c) natural and forced draft furnaces; (d) waste heat boilers; (e) producer gas fired furnaces; (f) multiple fuels involving mixed gas, oil and gas, common or divided air supply, matching variable excess air requirements of different fuels under widely changing fuel proportions; (g) special furnaces, Isley stacks.

The solution of the problem, thus stated, involves thoughtful design as well as intelligent operation and control of the furnace. The open hearth furnace is a notoriously inefficient device, and until recent years very little consideration had been given to either design or operation for quality or economy. As a result, the application of control and the consequent improvement in operation is limited in its scope by inherent deficiencies in construction, and in such cases, the mere attempt at automatic operation reaps its great reward by proving the saving possible with refinement of design, insulation, etc.

But taking open hearth furnaces as they are an analysis of the operation which the operator performs, will indicate the proper approach to the question of control. The functions must be weighed individually and collectively to determine their susceptability to control. Ordinarily, the operator controls only the following, (1) Fuel valves, (2) Stack dampers, (3) Inlet damper (for forced draft), (4) Reversing valves.

By the proper manipulation of these four controls he must cope with all the elements of the basic problem, and the task is rather a formidable one.

THE REGULATOR

The mechanism by which these various operations are to be performed requires separate consideration. In the substitution of machine for human operations, it is possible to retain many of the elements of "intelligence" which we proclaim for the latter. The human operator responds to various degrees of stimulation to a correspondingly varying extent. If he is intelligent his response varies not only in direction, but in degree, in speed, and in acceleration, as required, and unless the machine or regulator is equally "intelligent" its natural advantage of continuity of operation will be wasted.

A short analysis of the four essentials of a perfect machine regulator is given to emphasize this point. Sensitivity, Speed, Power, and Stability are relative terms and therefore must be considered quantitatively in relation to the specific regulation problem involved.

The control mechanism proper is more readily described in terms of the natural division of apparatus involved and the relation of each element to the basic problem given in turn.

FURNACE PRESSURE—STACK DAMPER

A typical furnace pressure control is shown and its analysis given. By reducing air infiltration, it (1) reduces sensible heat loss in the flues, (2) raises the flame temperature, (3) makes for uniformity of the flame distribution and (4) reduces the velocity of gases across the bath. On leaky furnace it is practically an essential for satisfactory operation. It responds to changes in pressure on the order of a half of a thousandth per inch of water, and its power may be multiplied to ten thousand ft. lb. per stroke with no loss in sensitivity.

Means are provided for speeding up reversals by electrically inter-locking the damper to purge the furnace of gases and permit instataneous ignition even though a cold shot of oil be delivered at the opposite port. The damper can be made to remain in position, to open wide for oil firing or close down for gas firing.

The furnace may be "drafted" at any time by the mere flip of a lever. Accurate indication of damper position and convenient manual are important features. A system using reversing gates for stack damper has been developed recently and is illustrated.

COMBUSTION CONTROL

Several modes of control are available and their relative merits discussed. For single fuels there are described three different modes of control.

(1) Master System—Including control for constant combustion rate plus fuel-air ratio or combustion efficiency. Most universal in scope and adjustment.

(2) Fuel-Air Ratio Controller. Control for proper combustion but no provision for constant fuel rate.

(3) Fuel Flow Controller. Constant fuel rate only. Air rate set manually.

MULTIPLE FUELS

Control of multiple fuels is very easily accomplished wherever air supply can be split up and a measured quantity of air proportioned to each individual fuel, and requires a fuel-air ratio device for each fuel.

If the air duct cannot be split up then the BTU value of the various fuels must be totalized. This involves two problems, (1) that of totalizing square root functions and (2) ready adjustment for varying fuel proportions with corresponding variation in excess air requirements.

A master air flow is produced and divided into a series of component flows, each of which is used as a control force by the individual fuels. The total master air flow is used as a measure of the air required and since air flows are measured in the master, they are square root functions of the same type as the measurements of the direct fuel flows, consequently, proper totalization takes place.

In the type B element described first, the operator adjusts the constant air flow and the controller balances up the fuel flows to deliver this constant rate. If one fuel is shut off, the other fuels automatically take up the load.

In the type A element, the operator sets constant fuel flow and the air is made to follow automatically. If one of the fuels is shut off, the air flow drops to meet the new requirement. Therefore, the controller does not automatically reset for constant combustion rate when fuels are cut in and out.

The type A element is used when fuels having very different excess air requirements are being burned. Actually, the regulator does not totalize B.T.U.-air ratio but totalizes the true air requirement for each fuel against the total air. Obviously, when transferring from the gas like blast furnace gas to one like coke oven gas the actual B.T.U.-air ratio varies considerably.

MISCELLANEOUS CONTROLS

Special arrangements such as producer gas fired furnaces, Isley stacks and waste heat boilers require modification of the control apparatus, which must be made compatible with the other elements of the problem. For example, the reversing of Isley stacks requires special synchronizing mechanism and producer gas fired furnaces involve regulation of the firing rate of the producer.

The author recommends that shops that have not previously been equipped with open hearth control should be equipped with a most complete system rather than attempting to control one function or another individually. Only by making a laboratory of one of the furnaces in a given shop can the operator determine the particular requirements of their individual problem. A complete control enables them to operate under a variety of test conditions and determine the best mode of operation as a guide for the general routine of the shop.

RESISTANCE WELDING IN STEEL

WALTER ANDERSON

By WALTER ANDERSON, Vice President
and MALCOMB CLARK, Gen. Mgr.
Taylor Winfield Corporation
WARREN, OHIO

Abstract of paper to be presented before the A. I. & S. E. Convention, Detroit, September 22, 23, 24, 25, 1936.

▲ IN ALL MODERN steel mills there are many instances where continuous processing is used.

Practically all sheet steel is made in the mills in the form of coils. These coils are first made in the hot strip mill and their length is limited by the weight of billets they can handle. At the end of this process, they are covered with a heavy scale which must be removed by the pickling process. The vats in which the stock is pickled often exceed 100 ft. or more in length and the stock is pulled through by large rollers. It is, therefore, necessary to fasten the end of one coil onto the beginning of the next coil in order to maintain the continuous flow of material.

There are two general methods used to join the stock together. One is known as "stitching", and is purely a mechanical bond. The other method is "welding". In the case of light gauge narrow strips where the joining is merely for the purpose of maintaining a continuous flow of material, spot welding is used. In most cases, a manually operated welder is entirely satisfactory since the loose ends of the strips are readily handled and enough slack may be obtained to permit the use of this method. Where large width coils of heavy gauge are encountered, the problems are somewhat different. One of the methods made use of today consists of a large spot welder hydraulically controlled. The operator clamps the end of one strip and allows the beginning of the next strip to overlap by approximately 18″, and then makes a double row of spot welds across the overlapped area. The stock is then released and continues through the pickling solution. On coming out at the other end, the weld must be cut out and the finished coils are the same lengths as when they came from the hot mill. This serves its purpose of maintaining continuous flow through the pickling but the coils must be manually handled before entering the cold rolling mill. In rolling single rolls, considerable waste is experienced due to the loose ends. After cold rolling the strip is cleaned and the necessity for a second joining operation arises to keep a continuous flow of material through the cleaner. Here the hydromatic type of welder is admirably suited since it makes automatically a row of spots across the lapped sheet metal. As the coils come through the cleaning process, they are often cut into sheets for delivery to customer and there is some waste here due to odd ends at the place where the weld occurs.

The trend in modern mills is to eliminate all the handling of coils and the waste of material due to loose ends. To accomplish this, a butt flash welder is used just ahead of the pickling vats. A suitable pit is provided to take up the slack in order to allow time for welding. The stock processing is then continuous right through pickling, cold rolling and cleaning, the cutting at the end being done by flying shears.

A modern installation of this type provides for the butt flash welding, transferring from welder to trimmer and subsequent trimming of the weld flash from both sides of the strip stock. The welders are of the latest automatic hydraulic type and give the operator full control of the welding operation at all times. A starting lever is provided, which when moved forward, opens a valve and starts the welding cycle. The upset slide moves forward, at a predetermined speed with proper acceleration and when the flashing period is finished, the current is automatically cut off and the upset is made. The operation is entirely automatic yet the operator may reverse the machine at any time by movement of a control lever.

As a result of considerable experimenting, it has been found that welds made by machines of this type in low

MALCOMB CLARK

carbon steel are of such a quality that when the stock is taken from the finished end of the cold rolling mill no evidence whatever of the weld can be found.

The foregoing covers the subject matter but it is thought that in the remaining time, a description of some of the more recent developments in welding machinery would be of interest to the members of the Association. At the present time, the development of welding processes is making possible the use of steel in the manufacture of many products which previously used other materials. For example, improvements in welder design and the use of electronic devices for accurate time control have made possible the production of vacuum tight welds. This has started a decided trend toward the use of steel for the envelopes of high vacuum electronic devices previously made of glass. For sometime now a large number of barrels have been made of steel whereas in the past, wood was the universal material. The modern streamline trains are an excellent example of some of the modern applications of resistance welding. As far the future is concerned, there is every indication that resistance welding will be used more and more for fabrication automatically carrying with it the increased use of steel.

INDIVIDUAL MOTOR DRIVES ON STRIP MILLS

By F. E. HARRELL, Asst. Chief Engr.
and W. R. HOUGH, Experimental Engr.
Reliance Electric & Engineering Co.
CLEVELAND, OHIO

Abstract of paper to be presented before the A. I. & S. E. Convention, Detroit, September 22, 23, 24, 25, 1936.

▲ TWO YEARS ago a paper was presented including historical data on some of the earliest installations of individually driven rollers. The present paper focuses attention on the experience secured from the latest installations where the width of strip handled and the speed of handling have been so greatly increased.

The expansion in number of size of hot strip mills during this time has made available a wide variety of installations and operating conditions which, if reported completely, would greatly exceed the permissible length of this paper which particularly deals with oscillograph tests on individually driven rolls for run-out tables and coilers on modern wide hot strip mills.

To one who has followed the articles published successively in the "Iron and Steel Engineer", it might appear that there are two separate and distinct schools

F. E. HARRELL

of thought, namely, (1) "Group Starting". That method of control which leaves the motor alternator set running at operating frequency and brings the full table into motion by successively—at predetermined time intervals—throwing portions or groups of the whole table directly on the alternator, and (2) the so-called "Frequency Control". The complete group of motors is thrown on the frequency set while it is running at base or low speed. The whole system is then accelerated to top speed by increasing the speed of the driving motor, the frequency proportionately increasing.

In the author's opinion, there is such a basic difference in performance operations required and costs involved that neither system can readily be chosen without a complete study of a particular mill. The two systems are not competitive but rather supplement each other.

Oscillograph tests of actual operating conditions show many things not otherwise discernible, such as the relation between the voltage applied to the shunt field—as controlled—and the actual rate of change of the field. The self inductance of the field circuit results in a time lag that can only be studied and corrected through successive oscillographic studies. The authors will offer findings in this connection dealing with both capacity of motor alternator set in kva. and various ratios of kinetic energy between motor alternator set rotor and connected load represented by squirrel cage motor rotor, connected roll and load.

Dealing with the problem of acceleration, operation figures will be submitted showing the actual power taken from the line by several methods of control, citing the benefits and handicaps of each.

There are several means at present employed for accomplishing the change in d-c. motor field strength to secure the necessary or desired operating characteristics on the "frequency control" motor alternator sets. In some cases the conventional flutter switch or relay which operates to strengthen (or weaken) the shunt field by virtue of the armature current drawn by the machine to be controlled gives entirely satisfactory results on certain sizes of machines. Other installations employ the time limit or dash pot control of the field strengthening (or weakening) relays, while still others employ motor-operated rheostats which rheostats are specially filled to produce desired characteristics inci-

dent to a continuously changing field strength during an accelerating or decelerating period.

With regard to the problem of acceleration as predicted by a known speed torque curve or a motor of known characteristic, it has been stated that no arbitrary factor establishing the relation between average effective accelerating torque and starting torque is practicable owing to the variables of friction, alternator loading, alternator regulation and the number of poles for which a motor is wound. With this the authors entirely agree. However, as the art advances, and with the information secured through the co-operation of the mills, empirical constants can be established which are entirely practicable, just as such constants are used daily in every field of machine design. These factors are based on experience.

Concerning the running condition and running loading of run-out tables, there arises only infrequently any abnormal condition where the equipment selected largely from the standpoint of the requirements of acceleration and deceleration does not entirely satisfy the operating conditions encountered.

Deceleration is a complex problem, complicated by the fact that operating requirements indicate the desirability of stopping in approximately one-half the time which was acceptable two or three years ago.

In any approach to this problem, the factor of the coefficient of friction of material to roll and table is the thing on which authorities all agreed many years ago. Still actual installations operating at a rate of deceleration in defiance of our available handbook information are deserving of study. To the same authors the same principle applied to the braking of high speed trains appears to be the nearest approach to the practical answer of how to stop more quickly, namely, by graduated braking to a degree made comparable with what must be a changing coefficient of friction incident to a change in speed. We are all aware of the fact that the present day locomotive when traveling 120 miles an hour has an automatic device which prevents the full braking effort from being applied until the train has been slowed down to a much lower speed, at which time the increased braking effort available is applied and brings the train to rest relatively quickley, whereas the application of the full braking effort at the top speed would only lock the wheels and cause them to slip, thus occasioning a marked increase of nearly 100% in the distance traveled by the train when stopping by the immediate application at top speed of maximum braking effort as opposed to a graduated braking effort beginning with a much lower figure at top speed. This phenomenon has been observed on some sheet tables where plug reversing was employed.

Apparently the most practical method of securing quick stopping of tables or coilers is through the use of d-c. for dynamic braking. If there seems any doubt as to the accuracy of this conclusion, comparative tests on actual mill installations should be conducted under the supervision of the electrical superintendent of the mill. A squirrel cage motor of any make or characteristic apparently can be stopped through the application of an entirely practical value of direct current potential, in about one-half the time it can be stopped by plug reverse and with no greater wattage input.

W. R. HOUGH

Interesting studies have been made as to the proper selection of alternator capacity for runout table drives. Curves will be submitted showing a maximum efficiency point in the production of torque at the runout table motor shaft in terms of alternator kva.

As bundle weights have been pushed ever upward, the job of coiling the strip becomes an increasingly difficult one. Test results in this connection offer interesting data.

Recognizing that the whole matter of individual motor drive originated from a desire to eliminate gearing with all the attendant problems of alignment and maintenance, the authors will offer an analysis of a hypothetical case outlining the specific comparison of size and percentage cost of a 3:1 speed range, 20-60 cycle gearmotor runout table drive and a direct-connected drive at a lower frequency, which in scheme of operation would exactly supplant the gearmotor drive by direct connection to the roll shaft.

MATERIAL HANDLING IN HOT STRIP MILLS

By F. M. GILLIES,
Ass't Gen. Superintendent
Inland Steel Company
INDIANA HARBOR, INDIANA

Abstract of paper to be presented before the A. I. & S. E. Convention, Detroit, September 22, 23, 24, 25, 1936.

▲ THE PROBLEM of handling the product of hot and cold strip mills is somewhat more complex than that which we face in other finishing mills, in that, first, the method of manufacture by means of individual processing units differs; and secondly, the great producing capacity of these individual units requires rapid and constant conveying to and from to permit un-

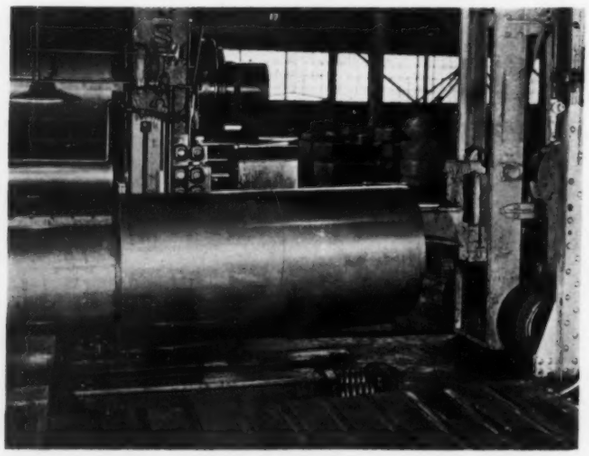
F. M. GILLIES

hampered and economic operation. True enough, the strip mills are only an advancement of the old hot rolling sheet units, but these old mills produced approximately ten tons per mill per eight hour turn, and the rolling units themselves required space which easily accommodated sufficient place for accumulation of the product after the squaring shears to permit ample time for overhead crane handling.

Other finishing mills by nature of the physical proportions of their product present similar problems which from time to time have seen progressive development, but in the main, there has been little fundamental change or improvement over a number of years. The constant study of engineers to eliminate irksome and slow hand labor has brought about conveying equipment advances, but in the main the overhead crane today does the bulk of the work.

The modern hot strip mill does not vary greatly from the conventional style of mill in handling its product.

However, in the rolling line of the hot strip mill there is one requirement that might bear mention. The roller table onto which the strip delivers from the finishing stand at a rate of approximately fourteen hundred feet per minute must be rapidly controlled from full speed to stop and this has necessitated precise workmanship of balanced rollers with individual motor drives adjusted in speed so that differentials that might cause scratching of the under surface of the strip, must be eliminated. Prior to transferring laterally to run out or prior to coiling, it is necessary to bring the strip to a sudden complete stop in less than five seconds. This has necessitated a refined type of roller table construction which has been well met by the machinery manufacturing engineers.



View showing coil which has been ejected onto tractor ram.

The processing equipment usually found in the finishing end of hot strip mills are normalizing furnaces, pickling equipment, scrubbers and dryers, cold rolling units, roller levellers, slitters and squaring shears. These units should be located in such a position as to require a minimum of reverse crane movements. Material must progress from the flying shears or the end of the flat strip runouts to the shipping dock, and certainly arrangement of processing units in this path lend themselves to economic operation.

Placing coil, by means of chain hoist on gib crane, in upender.

The use of overhead cranes serves mainly to the handling of this product because of the large tonnages to be handled per hour (which often exceeds 100 tons) and then to the physical size of the product. Wherever possible, roller conveyors, (gravity or power driven) of the Matthews type, are employed which in all cases eliminate hand labor. But in the main, the overhead crane of sufficient capacity and providing the processing units are so arranged as not to cause conflicting movement seem well able to handle the product.

From the coilers we have the problem of transferring the hot coils to a storage building and this is done by upending the coil into a vertical position on a sturdy conveyor chain. High maintenance will definitely assert itself on this equipment if not built properly. A slow moving chain in direct contact with hot coils must not expect much in the way of proper lubrication and therefore must be built strongly enough for long resistance to severe treatment.

This conveyor chain takes the hot coil from the level of the coilers to coil storage space usually located at the head end of the continuous pickling lines. At the point of removal of the coil from the transfer chain a magnet attached to the overhead crane is a satisfactory method of handling. Two coils can be handled easily

Articulated type sheet loading tractor entering box car with 11,000 lb. load.

at a time and tiered in such a way as to make the most of the space allowed. The magnet overhead crane is again employed to feed gravity roller conveyors to the feeding end of the continuous pickling units, but here it is necessary to take the coil from the vertical to the horizontal into the coil boxes feeding the pickling units. A number of coils are loaded onto a brake-controlled gravity conveyor which can be controlled by the operator at the feed end of the pickling units and while one coil is feeding through the pickler, the operator may allow one coil at a time to roll down onto an upender which in turn delivers the coil onto an incline table just before the pickling line, where the coil is blocked until needed, and at that time allowed to roll down into the coil box.

At the delivery end of the pickling unit the strip recoiled is ejected again onto a gravity conveyor, progresses over a scale in the line and delivered into the space in front of the cold reducing units. A magnet crane in a leanto bay, which traverses the length of the space in front of the cold reducing units adapts itself well to the distribution of the coils, but it is also completely practical where the travel is not great, to employ a ram tractor to transfer from this point to the incline in front of the coil box of the tandem mill.

Straddle type tractor picking up load from roller conveyor.

From the tension reel on through the processing that follows, tractor units adapt themselves particularly efficiently to the work, through the flying shear to the annealing, from the annealing to the skin passing units, to the resquaring or stretcher levellers or other processes, to the shipping department and to the gondola or box cars. Ram tractor, straddle type tractors, towing tractors and sheet loading tractors play an all important part in the handling of the product. The overhead crane best serves in this department in the product handling. It handles heavy loads where its movement is a minimum of travel and mainly vertical, serving the loading of annealing boxes and the loading of gondola cars and trucks best. The value of gravity conveyors for line transfer is great and wherever possible should be worked into service.

There is still room for development in material handling facilities ,and it is fair to assume that the marked progress made in the last ten years, particularly in automotive conveying equipment, where development has surely not yet reached its ultimate. The great need for economic handling in this highly competitive industry will force further development which will insure less damages to these high grade products and a lower cost to the consumer.

SOAKING PIT OPERATION

By P. M. OFFILL, Vice President
Amsler Morton Co.
PITTSBURGH, PA.

Abstract of paper to be presented before the A. I. & S. E. Convention, Detroit, September 22, 23, 24, 25, 1936.

▲ THE ABSENCE of leaching of the ingot surface in the AMCO Pit is of especial interest to sheet steel producers. The indicated reduction in losses from this cause appears to be not less than 5%, when compared with conventional practice. This great saving indicates a quick amortization rate for the pit and makes it especially interesting to the sheet steel producer. This change in the surface of the ingot is due to the absence of incipient fusion which, at the temperatures required in pits in an ordinary practice, leaches certain intergranular deposits from the ingot surface, increases the scale thickness and alters the character of the scale. Scale from steel heated in the pit is loose, falls off readily, because it is smooth on both sides, leaving an undamaged ingot surface. It is obvious that the surface of the matrix body is elongated in the mill and merely extended to form the surface of the finished product.

P. M. OFFILL

Labor saving due to the great reduction in bottom making—this results from absence of washing and reduction of scale thickness. This is a positive barometer assuring longer life for all the refractories.

Fuel required is about 40% of that of a good regenerative pit.

Coke saved amounts to about 10 tons per hole per week.

Iron content of slag averages 22% for the pit as compared with 60% for average practice. This light slag makes mechanical removal certain. Iron accumulated per hole per week is 180 pounds as compared with 2700 pounds.

The design and method of operating the pit is different than accepted practice. It incorporates every conceivable means to effect economy and avoids known but accepted evils. With such vast changes, new and hitherto unexpected results were anticipated and, as the foregoing indicates, achieved with the utmost simplicity in a unit which has operated sufficient time to prove that it is not only dependable but a new asset with new and desirable characteristics.

STEEL PRODUCTS IN THE ELECTRICAL INDUSTRY

By O. A. TILTON, Industrial Engineering Dept.
General Electric Company
SCHENECTADY, N. Y.

Abstract of paper to be presented before the A. I. & S. E. Convention, Detroit, September 22, 23, 24, 25, 1936.

▲ PRIOR TO the World War, arc welding was little known as a manufacturing tool. Such use as was made of it at that time was largely confined to repairs of broken machine parts. In fact, very little was known about it and certainly no appreciation then existed as to the metallurgical factors involved and the possibility of applying the knowledge and technique of steel making to its use. Electrodes used were of almost any kind of bare wire, irrespective of its analysis, and fluxes were little used, if at all. This continued, with little change, excepting that more rigid specifications for welding wire were established and light coatings of fluxing ingredients were used, mostly to improve the ease of manipulation of the arc. This continued until about 1930.

During the period from 1918 to 1930, the use of arc welding gradually extended into the manufacturing field, for new structures as well as for repair uses. The major factors that limited its use were low ductility of weld metal, low tensile strength and low resistance to corrosive action. However, it was entirely suitable for many structures subjected to static loading, such as generator frames and the structural steel framing for industrial buildings. Many castings were replaced even then by fabricated rolled steel assemblies.

The success attained in weight and material savings and satisfactory performance of those fabricated structures that were attempted was due largely to good mechanical design and a full appreciation of the limitations of the welds that could then be made. This was not enough, however, and welding engineers soon recognized the similarity between the welding arc and steel making in controlled atmosphere electric arc furnaces. The application of these principles brought heavily coated or shielded arc type electrodes about 1930, since when the physical properties of weld metal have become the equal of, and frequently better than, rolled steel.

It requires but little imagination to picture the vast market for standard steel-mill products that has immediately resulted. The replacement of steel castings by welded construction has not only reduced weight and material, but has increased strength, provided more space for ventilation and thus increased capaci-

ties for electrical equipment; and made possible the more efficient use of steel by design for stiffness where needed. The improvements in weld quality have removed a most important hinderance to the designers confidence in welding, with the result that there is practically no steel structure today than cannot be fabricated by welding.

In electrical manufacture, arc welding is used for stator frames of motors and generators from the small general purpose units of 25 or 50 horsepower to the largest hydro-electric units that have ever been made. The domestic oil burner, air conditioning equipment, electric refrigerator, dish washer and kitchen waste disposal unit are some of the smaller products that depend on welding construction. Some of the other uses of greater magnitude include turbine casings, machine bases and railway locomotive frames. There is, of course, a large amount of plant equipment of a special nature involved in the manufacture of welded products. This is most economically and quickly obtained by arc welding fabrication. Factory buildings which have to be altered, enlarged or strengthened and even new buildings make use of the all-welded design, saving material, time, labor, engineering and drafting expense, increasing the plant capacity and, of course, utilizing more and more tons of standard steel-mill products.

It would not be possible to obtain an accurate figure showing the increased use of steel thus brought about, by merely comparing the quantities used by any one concern each year for several years. This is also dependent on business conditions and such figures would contain so many variable factors that they would be grossly misleading. We think, therefore, that the clearest idea may be obtained by taking some typical product and comparing its weight as a cast steel structure and then analyzing the weight of the different kinds of standard steel mill products going into the replacing structure fabricated by arc welding.

Our example will be a stator frame for a large water-wheel driven generator which is 30 ft. in diameter and 10 ft. high. Its net calculated weight was 131,000 pounds, but on account of foundry allowances, the finished frame weighed 170,000 pounds gross.

The fabricated unit had a total gross weight of 110,000 pounds, or a saving of 60,000 pounds gross weight. This was made up of:

92,000	pounds of	Plates
13,300	"	" Rectangular Bar Stock
3,200	"	" Round Bar Stock
1,200	"	" Pipe
300	"	" Angles
2,100	"	" Electrode Wire

Of course, all of this meant the use of standard steel mill products and was entirely new business for which arc welding was wholly responsible.

After studying these figures, one has to form a personal estimate or idea, from a general inspection of the extent to which arc welding is utilized in some specific manufacturing concern. Of course, we take General Electric as our example. These welding activities are carried on in each of our numerous factories, scattered as they are from coast to coast and from Canada to Mexico.

Slides have been selected to illustrate visually the use made of arc welding in electrical manufacture and thus the extensively increased use of standard steel mill products in this industry.

STEEL PLANT LUBRICATION

By C. J. KLEIN, Chief Engineer
Weirton Steel Company
WEIRTON, WEST VIRGINIA

Abstract of paper to be presented before the A. I. & S. E. Convention, Detroit, September 22, 23, 24, 25, 1936.

▲ THE PURPOSE of this article is to record as far as possible incidents relating to the lubricating problems and difficulties encountered in the regular operations of various types of steel plant equipment in the hope that some one incident will prove helpful to the engineer or operator to foresee or correct a similar condition in his plant.

In considering the installation and operation of lubricating units, several important factors must be taken into account—

1. Service and type of equipment to be lubricated.
2. Accessible location for lubricating equipment.
3. Proper trenching and protection of lines.
4. Temperature control for both maximum and minimum temperatures for producing proper flow of lubricant.
5. Location of piping with reference to bearings, gears and moving parts.
6. Type of finish of friction surfaces, grade of castings, etc.
7. Protecting lubricant from infiltration of foreign matter and the removal of same if necessary.
8. Correct type and grade of lubricant.

In the design and piping of gear reducing and pinion

C. J. KLEIN

stands such as are used with continuous hot and cold strip mills, extreme care and thought must be given to the proper location of oil pipe connections and outlets for the lubrication of the gears, pinions and bearings and in this connection several instances have come to the writer's attention that when changes were made, increased life of the mill pinions was accomplished. In the lubricating of the mill pinions in a two-high pinion stand the oil from the circulating system was discharged into a common receiver in the top of the pinion housing cap and then permitted to flow through a series of holes and drop onto the top of the upper pinion. The revolving of the pinion carried the oil into the mesh of same which, in this case, was 180° distant. It was found that a large amount of oil was lost by the time meshing occurred and that rapid wear was the result on the pinion teeth. Pipes were then placed at the pitch line of the pinions and as close as possible to the mesh of same, spaced about 6″ centers and located so that the oil would be carried into the mesh of the pinions. The result of this change was such that the life of the pinions was practically doubled.

Another case dealt with a similar arrangement in that the piping as originally installed was not placed sufficienctly close to the mesh of the pinions that the oil had a tendency to run off before its purpose was accomplished. In addition to this the spray pipes staggered the apex of the teeth and this also provided improper lubrication. The result was that wear was noticed on the teeth within a few weeks' time. The piping was then changed so that one outlet was located at the apex of the double Herringbone pinion and the remainder of the piping on approximately 5″ centers on either side the center, and located as close to the mesh of the teeth as was possible. The result was such that apparent wear on the teeth ceased immediately.

A continuous lubricating system which was installed in connection with tandem cold rolling mills had one of the roll stands and drives removed. This, of course, eliminated the necessity of the oil piping in connection with this unit. However, this piping was not removed due to being underground and rather inaccessible. Some time after this change several bearings in the remaining drives which were lubricating from this continuous system began running hot. The Master Mechanic thinking this to be a temporary difficulty, added oil to these bearings and applied air for the cooling of same. However, this condition continued and the gears and remainder of the bearings were then inspected and it was noticed that the oil was showing a demulsification. The indications were that an excessive amount of water was getting into the lubricating system and upon an analysis of the oil a certain amount of sulphuric acid was indicated. After a thorough investigation it was found that one of the abandoned lines had become corroded to such an extent that the pipe was eaten entirely through and acid and water which was leaking through the foundation from an adjacent pickling department was getting into the system. The acid had formed a sludge on the bottom of the oil reservoir and it was found necessary to drain the entire system and replace same with new oil.

In this connection it would be apparent that all pipe lines which are not in use should be disconnected from the oiling system.

With the installation of automatic grease systems on roll neck bearings it is the usual practice to install rubber hose between the pipe line and the bearing, due to the necessary adjustment of the bearing when changing roll diameters. Ordinarily these hose do not require a great amount of attention, but on one occasion it developed that a bearing ran hot and a complete inspection of the entire feed line was made to find the source of the leakage but none was found. The piping was then dismantled and no obstruction was found in the metal pipe. However, upon trying to run a wire through the rubber hose it could not be done. The hose was then cut in two and found to be completely closed. The hose being made in two layers had separated and expanded, thereby closing the hole. A periodical inspection of rubber hose is advisable both in and outside as far as possible.

Temperature warning devices are desirable in connection with costly bearings, set so that upon reaching a predetermined temperature they will warn the operators.

ELECTRICAL STRIP MILL EQUIPMENT

By L. A. UMANSKY,
Industrial Engineering Dept.
General Electric Company
SCHENECTADY, NEW YORK

Abstract of paper to be presented before the A. I. & S. E. Convention, Detroit, September 22, 23, 24, 25, 1936.

▲ IT IS IMPOSSIBLE to produce hot strip without electric power. Blooms or slabs, shapes or plates, even merchant bars can be conceivably rolled, even though not economically, by steam power. But a modern hot strip mill, of any known type, simply can not be designed, built or operated without electric motors to drive it. Electric motors are not attached to the mill equipment; they are part of this equipment.

The essential elements of an up-to-date hot strip mill appeared in about 1920. The 14 in. mill built for the then Trumbull Steel Company (now the Warren Plant of the Republic Steel Corporation), with all stands arranged in tandem, set on close centers, and with practically all of them individually driven, presented essentially the same problems to the electrical engineers as they have to meet today.

The Butler mill of the American Rolling Mill Company, built in 1926, opened our present era. The roughing end of the strip mills built since that time has undergone several changes in layout, but the type of finishing end remains substantially the same.

The roughing work is done either on a reversing universal stand or on several tandem stands. In the first case a reversing d-c motor is used with a separate M-G set and generator voltage control,—a relatively expensive equipment.

If the tandem roughing stands are set far apart and the slab leaves one stand before it enters the next one,—then constant speed motors are conventionally used, one per stand. The overall cost of the electrical equipment is lower, but the cost of the mill itself and the space requirements are higher than in the former case.

Several mills were built with roughing stands closely spaced and each driven by an adjustable speed d-c motor. This gives the most compact arrangement, but calls for the most expensive electrical equipment. Other factors except the cost of electrical equipment may influence the choice of spacing between the roughing stands.

The majority of strip mills built since 1931 have the roughing stands set apart and each driven by a constant speed motor, either induction or synchronous type. It would be wrong to generalize and to call this the "standard" arrangement. Next year the trend might be entirely different.

The finishing stands are always set on close centers and are driven individually by d-c adjustable speed motors. Not less than 2:1 speed range is usually provided, and in some cases it is increased to 3:1 or more. It is obtained by motor field control. This means that constant horsepower is available throughout the speed range. Power to these motors is conventionally supplied from synchronous M-G sets. Generator voltage control is used for starting and stopping, and also for increasing the speed range of the mill as a whole.

Speed regulation of d-c driving motors, i.e. the variation of speed from full load to no-load has been widely discussed in the past. Experience shows that this point has been often overstressed or misunderstood, causing at times some unnecessary expense.

On some of the largest modern mills the total capacity of the finishing mill motors is about 40,000 hp, and that of the generators—18,000 kw. This large concentration of power, usually at 600 volts, presents a problem of no mean magnitude in designing the 600 volt bus, the air circuit breakers, and other associated equipment.

A motor room of a wide hot strip mill includes close to 100,000 hp of rotating machinery,—considering the d-c and a-c motors, M-G sets for 600 volt and 250 volt power, etc. The losses resulting from this conversion of power may amount to about 4000 kw. This loss is dissipated in the motor room as heat. Unless the latter is disposed of the temperature of the motor room becomes unbearable—for machines and men alike. Old-fashioned or "conventional" ventilating systems become obsolete. Modern methods—downdraft ventilation, recirculation systems— become imperative. A good deal of engineering thought has been devoted to this problem in arranging up-to-date motor rooms.

A wide hot strip mill calls for a very large investment. Not many small-scale steel producers can afford it. Yet, they can ill afford to stay out of the strip game. Hence came the idea of a reversing hot strip mill of the Steckel type. The entire roughing and finishing work (or finishing work alone) is done on a single stand. Two coilers are located one at either side of the mill. The material is passed back and forth through the mill from one coiler to another.

The coilers are located in heating furnaces. The mill, tables, and the coilers are driven by separate reversing motors. They accelerate and reverse in synchronism. There are three such mills in operation in U.S.A. and in Canada. Electrical equipment is highly special, but has met quite successfully the rolling requirements.

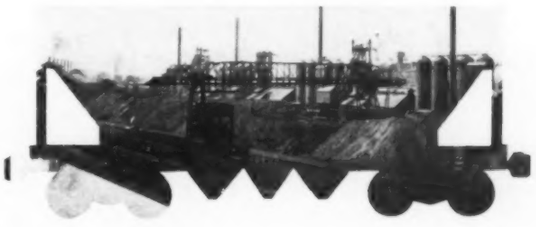
Quite obviously, the initial investment for a mill of this type is much lower than for a continuous mill. Its tonnage is, of course, also lower. How wide an application will be found for such a mill will be determined by economic factors and by the quality of the product.

It is not enough to roll hot strip. It is equally important to handle it after it is delivered from the finishing stand. Electric drive solves this problem too.

Electrically equipped flying shears cut the strip at speeds up to 2000 fpm into commercial lengths, with an accuracy of $\frac{1}{16}$ in., or better. The same shears also crop the ends of the strip which is then delivered to the coilers.

Runout tables and strip coilers, with rollers individually driven by separate motors, also continue to occupy the attention of designers of electrical and mill equipments. It is believed that many improvements in this field are yet to come.

Modern world can not exist without steel strip. Strip mills can not exist without electric power and control. Steel and electricity are wedded together. This union should continue to be a happy one.



Steel Mill Developments

—REPORT OF A. I. & S. E. COMMITTEE

By W. H. BURR
Electrical and Mechanical Supt.
LUKENS STEEL CO., COATESVILLE, PA.

Paper to be presented before the A. I. & S. E. Convention, Detroit, September 22, 23, 24, 25, 1936.

▲ THE PASSED year will be remembered by some as the advent of boon doggling sponsored by our National Government, by others, for the growing unrest in the labor situation, but it will be remembered by all as that period when taxation increased to a point difficult of human conception.

Industry, while enjoying at present the best production rate in the past five years, faces the future with some uncertainty. The depression whether we liked it or not was necessary and has strengthened industry. If granted freedom from political control, industry will meet today's conditions and go forward, for it has been modernized and rebuilt.

MAIN ROLL DRIVES

The great bulk of mill equipment and electrical apparatus installed or purchased during the past years was connected directly or indirectly with the construction of new strip mills.

Hot Strip Mills

The concentration of power on a continuous hot strip mill is tremendous; several mills already in operation or under construction each require close to 40,000 HP. in main roll drives only. For instance, the 96 inch continuous hot strip mill of the Great Lakes Steel Corporation has five induction motors driving the roughing stands with their associated scale breakers; these motors are rated one 1000 HP. and four 3000 HP. The finishing stands and the second scale breaker of the same mill are driven by five 4500 HP., one 3000 HP. and one 500 HP. 600 volt DC. adjustable speed motors. The power to the latter is furnished from three 6000 KW. M-G sets. It is interesting to note that the Great Lakes Steel Corporation's hot mill combines the maximum width of strip rolled with the maximum operating speed in use today. This speed is understood to be close to 2000 RPM.

A practically identical mill is now under construction by the Jones and Laughlin Steel Corporation, Pittsburgh, Pa. The capacity of the driving motors is also the same. The 79 inch hot strip mill of the Bethlehem Steel Company, Lackawanna, New York, was put into service late in 1935. The rating of the roughing mill drives is identical with the other two mills, but the finishing stands are driven by two 4500 HP., three 3500 HP., and one 500 HP. DC. motors.

Cold Strip Mills

The development of the cold strip mills has kept pace with that of the hot mills. Both tandem mills and reversing mills were extensively used. Probably the largest amount of power concentrated on a single cold mill is that used on a three-stand tandem mill in the Chicago District. The main rolls are driven by one 1500 HP. and two 2500 HP. motors, while the tension reel is equipped with a 350 HP. motor. The power to these drives is being furnished from a 6000 KW. M-G set.

A new 72 inch reversing cold strip mill at the Gary Sheet Mill of the Carnegie-Illinois Steel Corporation is driven by a 4000 HP., 150/300 RPM. main motor and two 1500 HP., 150/525 RPM. reel motors. This is the greatest amount of power yet applied to a single stand reversing mill. A new 42 inch tandem mill in

the same plant is driven by four 1250 HP., 300/600 RPM., and one 500 HP., 400/800 RPM., 600 volt main motors and one 250 HP., 250/1000RPM. reel motor.

Other cold mills under construction in 1936 include a 26 inch reversible mill for the Crucible Steel Company with one 800 HP., and two 250 HP., 600 volt motors; and 80 inch tandem sheet mill for the American Rolling Mill Company with three 1500 HP. and one 600 HP., 600 volt motors; a 30 inch tandem tinplate mill for the Crown Cork & Seal Company with five 600 HP. main motors and one 100 HP. reel motor; a 42 inch tandem tinplate mill at the Weirton Steel Company driven by one—400 HP., two 1000 HP., one 1500 HP., and one 200 HP., 600 volt motors; a 30 inch single stand mill at the West Leechburg Steel Company with one 800 HP., and one 300 HP., 250 volt motors and a 42 inch reversible mill for the Youngstown Sheet & Tube Company with one 1750 HP., and two 500 HP., 600 volt motors.

Reversing cold strip mills of the Wallingford Steel Company, Wallingford, Connecticut, and of the Detroit Steel Company, Detroit, Michigan, were put in service during the year. Each mill is equipped in a conventional manner, with one DC. motor driving the main rolls and with two other DC. motors driving the winding and unwinding reels.

Mill operators are continuing to give more and more importance to the maintenance of constant tension while rolling cold strip. The electrical industry responded to this requirement by developing some special apparatus. The three-stand tandem cold strip mill at the Ford Motor Company's plant at Detroit, started in 1935, is equipped with such apparatus. An idle roller is installed between the stands 1 and 2, and another one between the stands 2 and 3. These rollers are resiliently supported and the passing strip tends to push them downward. The vertical movement of these rollers is infinitesimally small, but is detected and measured electrically. The electrical values thus obtained are used to suitably control the speed of the motors, 1 or 2, respectively, and to maintain thereby a constant tension between the mill stands. In addition to this, means are provided to indicate the difference, if any, between the strip tension at either edge of the strip. The equipment has been in service for many months and is performing quite successfully.

Skin Pass Mills

The so-called skin pass mills, or tempering pass mills, are now requiring a more elaborate electrical equipment than was considered necessary even one year ago. In addition to the mill and the tension reel motors, a skin pass mill is now often equipped with a so-called "puller" which is located between the mill itself and the tension reel. This puller, consisting of several pinch rolls, is driven by a separate DC. motor. These rolls exert a definite tension on the strip at the delivery side of the mill, this tension being automatically controlled by electrical means. The tension on the winding reel is controlled independently, and may be held at a value different from that held at the puller. In certain cases an identical puller is installed at the entering side of the mill, that is, between the feed reel and the main rolls. This puller is also driven by a separate motor, and the tension which this motor exerts on the strip at the entering side of the mill is again controlled electrically. Finally, the feed reel, itself, is now conventionally driven by two feed reel motors also known as "drag generators". The feed reel consists essentially of two steel cones between which the coil is placed. Each cone is driven by a relatively small DC. motor, which is used for jogging the reel in order to thread the strip into the mill. After the strip has entered the rolls the feed reel motors begin to act as drag generators, creating thereby a suitable tension on the strip as it leaves the feed reels. This tension is, again, maintained electrically at a desired value.

By means of these improvements the uniformity of the finished product is maintained much more accurately than possible previously.

Rod Mills

Although the strip mills were holding the center of interest, steel mill activities were also noticeable in other lines. The American Steel and Wire Company has purchased two large synchronous motors to drive continuous rod mills now under construction. Each motor is rated 4500 HP. 400 RPM. 6600 volt 60 cycle. One interesting feature of this application is the necessity of obtaining a high starting torque with a relatively low power input from the power system. This was done by a special design of the starting winding of the synchronous motors and of the starting autotransformers. As much as 90 per cent starting torque can be obtained with the power input limited to 7000 kva.

The main drive for a new semi-continuous rod mill in the Chicago district consists of one 2000 HP., 277 RPM. and one 1250 HP., 900 RPM. synchronous motor, and three 300 HP., 250 volt, DC. adjustable speed motors with 3/1 speed range. The reels are designed to receive metal over a speed range of 250 to 3600 feet per minute. Each of the four reels is driven by a double unit motor with a nominal rating of 60/80 HP., 400/1600 RPM. arranged for either series or parallel operation, of the armatures. By a combination of field control, variable voltage and series and parallel armature connections, the reel motors are made to operate over a speed range of 15/1. The reels for another new rod mill in the Chicago district will be driven by twelve 125 HP., 230 volt, 400/1200 RPM., DC. motors supplied from two 300 KW. variable voltage generators, giving a total speed range of 140/1200 RPM. Improvements at a third rod mill in the same district involved the installation of a 700 HP., 705 RPM. induction motor.

Blooming Mills

To drive a 46 inch reversing blooming mill, the Inland Steel Company have installed a 7000 HP., 50/120 RPM reversing motor with flywheel motor-generator.

Plate Mills

The drive for the new 100 inch reversing roughing plate mill at the Homestead Works of the Carnegie-Illinois Steel Corporation, consists of a 7000 HP.,

40/80 RPM. main motor and a 600 HP., 125/406 RPM. edger motor, supplied with power from a 6000 KW. flywheel motor generator. The 7000 HP main motor has a maximum circuit breaker torque of 2,500,000 pounds feet and is one of a very few motors designed for this speed and torque. The spreading stand which precedes the roughing mill will be driven by a 4500 HP. 370 RPM. induction motor with a flywheel.

Merchant Mills

A new merchant mill at the plant of the International Harvester Company will be driven by one 3500 HP., 175/350 RPM. and three 1500 HP., 300/600 RPM. main motors and one 200 HP., 400/800 RPM., and two 150 HP., 300/800 RPM. edger motors. Power supply is from a 5000 KW., 600 volt synchronous motor generator.

Bar Mills

A new 21 inch continuous bar mill in the same plant will be driven by one 1500 HP., 225/450 RPM., one 1500 HP., 300/600 RPM., and four 2000 HP., 300/600 RPM., 600 volt main motors and two 200 HP., 400/800 RPM. edger motors. 600 volt DC. power will be supplied from a 7000 KW. synchronous motor generator.

Billet Mills

For driving a new 32 inch billet mill, the International Harvester Company have purchased a 4000 HP., 75/165 RPM reversing motor and flywheel motor generator.

Replacements

To replace an engine drive on a universal plate mill at the Youngstown Plant, the Republic Steel Corporation installed a 4000 HP., 112½/160 RPM., 600 volt DC. motor with synchronous motor generator and variable voltage control.

The American Rolling Mill Company increased the width of their Middletown hot strip mill to 80 inches and installed a new 4000 HP., 400 RPM. synchronous motor to replace the original DC. drive, which was moved to a new stand.

MILL EQUIPMENT

Development has been concentrated largely on the mechanical equipment for the cold finishing departments in order to speed up and cut the cost of production along with the making of a better product. Several additional 4-High Cold Reversing Mills have been installed for the production of strip in light gauges and tin plate. The versatality of this type of mill to start with random gauges for the production of uniform light gauge strip has been more thoroughly realized due to the balancing of the reductions with the number of reversals necessary to produce the required gauge.

Pressuremeter

A pressuremeter has been developed to answer the need of a simple inexpensive unit for indicating or recording the rolling loads of all types of hot or cold mills in order to balance the passes. By balancing the rolling schedule with a definite relation to separating pressure, roll neck bearings and mill roll life has been extended.

The units are mounted in the housing posts of new mills with the cover of each unit flush with the post surface. On existing mills, the unit is welded to the housing post at a location that will not interfere with the changing of rolls or the passing of metal through the mill.

The unit consists of a gauge bar made of material similar to the material of the housing post itself so that the thermal co-efficient of expansion of the two materials is as close as possible. Each unit is equipped with a rugged standard type AC. wattmeter indicating instrument or standard rugged recording equipment.

Differential Cooling Tables

For the purpose of obtaining uniformity of gauge of hot rolled strip as it is delivered from the finishing train, there has been developed a differential cooling table placed between the roughing and finishing stands, whose function it is to so cool the strip—more in the front than in the back—that as each element enters the finishing train it is at exactly the same temperature as every other element. Where thicker material is being rolled, this table may be used for accelerated cooling of the material itself. Where no general cooling is required, the obtaining of a uniform temperature to the end of obtaining uniformity of gauge does not involve finishing the strip at a lower temperature than an unequalized strip, since in this case the front end would only be cooled down to the temperature level of the back end. The apparatus as designed is flexible, so that the times of cooling are variable over a wide range, the controls being set to operate automatically for each schedule of material being rolled.

Belt Wrapper

The development of the belt wrapper for tension reels speeds up production by the elimination of the time ordinarily necessary for the gripping of the strip in the reel and eliminates the crimped end that so often makes stripping difficult. The unit is moved into place at the reel by an air cylinder and the belt surrounds the drum except for a small opening for the entry of the strip. After a few revolutions of the drum, the unit is moved away and clear of the reel. This arrangement can handle strip at any desired delivery speed of the mill.

Pickling Strip

An entirely new principle of pickling strip in individual coil form has been developed through the central mast idea and a method of mechanically rotating the coil in the bath with the acid circulating at the same time, thus obtaining accelerated action and eliminating the usual spreaders in the coil itself. This has been developed especially for steel plants of limited tonnage.

Strip Coil Lifter

The strip coil lifting hook has a wide variation in the width and diameter of the gauge to be handled by the overhead crane. The tongs are held in open position by a latch until the unit is rested on the coil. The latch may be tripped by hand or by a solenoid, which allows the tongs to close in on the coil in parallel motion on rails as the crane starts the lift. The discharge of the coil is completely automatic and the latch drops in place to keep the tongs open for the next lift.

Drum Type Flying Shear

The further simplification and efficiency of the drum type flying shear for both Hot and Cold Strip Mills has been an outstanding development.

Precision Fabric Bearings

A new standard variable speed Continuous Billet Mill consisting of six 21″ stands and equipped with precision fabric bearings is now under construction. This Billet Mill is preceded by a 32″ secondary 2-High Blooming Mill and will also be equipped with a mill speed precision flying shear to cut up to 4″ squares to commercial lengths. The layout will also include three electric stationary shears for hot and cold blooms and billets and the necessary edging mills and tables to make a complete installation.

Alloy Roll

A new special process alloy iron roll has been developed primarily as a substitute for the very hard grade of nickel iron roll. It will show a hardness in line with the various makes of hard nickelrolls but with the advantage of a soft iron neck, thereby eliminating the necessity of grinding the necks, keyways, etc. The roll can be machined on regular roll shop equipment. This lessens the cost materially over the regulation hard nickel roll.

Tilting Table

Two Tilting Type Tables are now under construction with air operated wrench type manipulators to turn and handle squares and ovals for a 28″ 3-High Mill.

Roller Bearings

The ability of certain spherical roller bearings to take thrust in both directions and sustain this load under misalignment has been utilized in the application of this type bearing as a thrust carrier for back up rolls in a great number of four high hot and cold rolling mills. As a matter of fact, the rated annual production of continuous hot strip mills utilizing this bearing for back up roll stabilization totals 2,400,000 tons, which comprises almost twenty-five per cent of the rated production capacity of all modern continuous strip mills of the country. In a new 96″ continuous mill with a rated production capacity of 720,000 tons per year, which is now being erected in the Pittsburgh district, the same back up roll thrust bearing will be utilized. Furthermore, all these stands are equipped with a special auxiliary roll mounted on two spherical roller bearings operating under combined radial and thrust loads.

In the Pittsburgh district a company rolling stainless steel furnishes an example of what may be accomplished by the substitution of spherical roller bearings for the ordinary plain bearings in two high cold mills. The modernization of these mills, which are of the size 12″ x 18″, brought their production capacity and efficiency to a point that compares favorably with that of entirely new equipment for the same rolling. The re-building of these stands accomplished at a relatively small expense, resulted in the ability to roll with higher speeds, heavier reductions, and maintenance of uniform gage from end to end of coil. In addition to these improvements a reduction in power consumption was realized which, it is claimed exceeded 65 per cent. Another advantage which had not been anticipated was the saving roll grinding costs as a result of maintaining the surface finish of the rolls for much longer periods than before. This is due to the fact that the use of roller bearings permitted the elimination of the water cooling for necks and rolls. In this case, the acid condition of the cooling water had promoted rapid corrosion of the roll surface, a condition which probably exists in many mills, and which can be remedied by changing the mills over to the anti-friction bearings.

Pinion stands and gear drives for rolling mills is another group of equipment in which spherical roller bearings have proven their merit. The transmission of great horse-power through pinions of limited pitch diameter have necessitated the use of very long teeth, and this in turn brought about an increased distance between bearings. Gears are, therefore, designed to work under a definite deflection and the gear manufacturers have also recognized the value of the spherical roller bearing for such applications. During 1935 spherical roller bearings thus were incorporated in twenty-six steel mill drives in the United States of America aggregating 36,200 HP.

Furnace Doors

A non-cooled furnace valve for open hearths, soaking pits and heating furnaces has been marketed for which a number of claims have been made. It consists of a heat resisting alloy steel seal and gate enclosed above floor level with a steel plate housing on which is mounted an integral motor driven mechanism used for raising and lowering gate. No water is used reducing the heat loss. No cables or counterweights are needed. It is accessible, of sectionalized construction and has individual motor drive.

Waste Heat Boiler and Heat Exchanger

When an open hearth furnace is equipped with a waste heat boiler a material saving is effected in heat which would otherwise be wasted. The value of this saving is measured by the cost of producing steam at the particular plant under consideration. Heat recovery by open hearth waste heat boilers usually is in the range from 900 to 1600 pounds of steam per ton of ingots produced, and a steam credit of thirty-five

cents per ton of steel is a general average figure. This saving has justified the installation of waste heat boilers at many plants and explains the wide acceptance of the fire tube type of boiler, by which it has been made possible.

There are cases where operators object to selling steam as a by-product of their department and thereby must be satisfied with a credit for heat equivalent only to cheap boiler coal. These men mostly are of the opinion that heat recovery from waste furnace gases should be returned to the furnace in the form of higher preheat to combustion air or fuel.

For the above reasons there has been developed a waste heat unit of practical size and construction for direct return of heat to the furnace. Its basic principle is the application of a metallic air preheater to the furnace without the need for expensive alloy steels in any of its elements. To do this requires positive protection of the preheater against overheating and consequent short lift. A short section of boiler is used to reduce waste gas temperatures to safe limits before the preheater. The boiler may be designed no larger than necessary to act as a precooler, or may be enlarged to provide flexibility in output of steam and air preheat. Control of air temperature to the furnace is accomplished by means of a large by-pass flue in the boiler, which is dampered to permit variable quantities of hot gases to pass and mix in the preheater. The position of the by-pass damper is regulated by thermostatic control from the hot air supply line to the furnace. The degree of preheat may be varied at will and will remain constant within close limits for all positions in the available temperature range. The same situation applies when fuel gas is the medium to be heated.

A valuable characteristic of the unit lies in the flexibility whereby waste heat may be directed to the point of greatest econonic use. If direct use of the heat is needed by the furnace, then the boiler element produces the minimum of steam. On the other hand, when preheat supplied to the furnace is cut down by the operator, steam production will be large. Thus, under all conditions of operation, all available heat in the waste gases is usefully employed. This advantage develops full use of preheat in melting down, which is desirable for greater tonnage and yields.

AUXILIARY DRIVES

Probably the most interesting development in the field of auxiliary drives is the decision of a large steel company in the Chicago territory to equip the screwdowns, mill tables, and side guards of their new blooming mill with Ward-Leonard control. Each of these five drives is equipped with two 150 HP. 450 RPM. 230 volt shunt wound mill type motors connected in series. The power to each pair of motors is furnished from a separate generator of the so-called "shovel generator" type; two such generators, connected in series, are provided for the screwdown drives. The bloom and slab shear is driven by two 275 HP. 230 volt motors connected in series, and furnished with power from two 250 KW. shovel type generators, also connected in series.

The chief merits of this type of control are as follows: Elimination of heavy contactors ordinarily required with magnetic control of motors of this capacity; elimination of resistor losses; high motor speed with full field on the motor (with this type of control it is expected that the screwdowns will move much faster than usually, particularly when the top roll is to be moved a considerable distance up or down as required in the slabbing work). Another advantage of this type of control is that the motors can be actually stalled without danger. This is due to the peculiar combination of fields on the three-winding or "shovel" generator, giving a definite (but adjustable) limit to the stalled current value. This feature is of particular importance for the side guards and shears.

Each hot strip mill requires a flying shear following the last stand. These shears are electrically driven and require some very special control. These flying shears are not only supposed to cut the metal into uniform lengths, but also to crop the front end or the tail end of the strip, or both ends, while the strip itself is not sheared but coiled. One shear of this type is in successful operation at the McDonald Mill of the Carnegie-Illinois Steel Company, another similar shear is installed at the Ford Motor Company's plant, and still another one is under construction for the Wisconsin Steel Company.

One of the leading motor builders reports the installation of a number of motors built for special application which are of interest. On a slab reducer a 700 HP. 230 V. DC. compound wound motor 500 RPM. was installed rated as follows: Continuous duty, totally enclosed, force ventilited, and designed with low WR^2. A 200 HP. 40° continuous rated motor 400/1200 RPM. 230 V. DC. with compensated shunt field was installed on a Skin Pass Mill in the Youngstown district. For Semi Continuous Sheared Plate Mill this same motor builder is furnishing a 500 HP. 500 RPM. 230 volt DC. motor with 70 per cent shunt and 30 per cent series winding to be used on a slab squeezer. This motor too is designed for low WR^2 and rapid acceleration and will carry peaks of 1000 amperes for sixty second peaks. For use on the 86" Ungerer Universal Roller Leveller in the Chicago district a 250 HP. 230 volt 850/1200 RPM. constant torque motor with compensated shunt fields was furnished.

CONTROL EQUIPMENT

This last year has been very encouraging from the control standpoint as a great deal of new equipment has been installed. Much of the new equipment has been for wide strip mills, including control for cranes, main and auxiliary drives, reels, coilers, and runout tables. In particular, the control for runout tables has seen quite a development because a number of them have been installed during this period. The control includes the starting and speed regulation of the main motor generator sets, the starting of the roll table motors in various groupings to meet different service requirements, and braking by the application of direct current. Operation is usually from one or two bench boards on which are mounted the operating

masters, emergency masters, speed control switches, signal lamps, instruments, and tachometers.

In connection with the main drives for strip mills, a number of large motor driven rheostats have been installed. Several ingenious mechanisms have been designed to insure that two or more of these rheostats may be operated together and remain in step while at the same time permitting individual operation. Geared head motors have been used for these rheostats to obtain a direct drive from the motor to the rheostats arm without intervening chains or countershafts.

Relays

The success of the inductive method of acceleration for direct current motors has led to the development of a similar method for use on alternating current. With one arrangement the standard alternating current contactors are used, being controlled by separate timing relays of the inductive type. In another arrangement special contactors are used which have direct current operating magnets, but contact and blowout structure suitable for handling alternating current. In both cases, direct current for the control circuit is obtained from a copper oxide rectifier mounted on the control panel. A number of controllers of this type have been installed in the past year for steel mill auxiliary drives and also for alternating current cranes.

A new type of overload relay for alternating current motors has been developed. This relay has the laminated magnet frame with a rotating armature and two coils mounted on the frame. Motor current flows through the primary coil. A secondary coil is connected to a bi-metallic strip. Under normal conditions no current flows in the secondary coil, but when an overload occurs, the armature of the relay rotates into its closed position, completing the iron circuit. Current is then induced in the secondary coil, heating the bi-metallic strip and causing the relay to open. The advantage of this relay is that no current flows in the tripping element until the motor current rises to the value at which it is desired to trip the relay.

Metal Clad and Factory Assembled Equipment

There is an evergrowing tendency of building switchgear panels of steel. This makes the switchgear more rugged, lighter in weight, and more pleasing in appearance. The instrument and relays are mounted semi-flush on the panels, still further contributing to the neatness of the appearance. Incidentally, the use of steel as panel material is particularly fitting to the switchboard installed in steel mills.

Several large steel companies have found it advantageous to purchase the magnetic control panels for the various mill auxiliary drives mounted on a self-supporting framework. The latter is completely built at the manufacturer's plant, is completely equipped with buses, the resistors are mounted usually on the top of the framework and are connected to the panels at the factory. Several such panels say ten or twelve, or more, may be shipped from the factory to the steel plant completely assembled on one framework, and it takes but a few hours to have such an assembled control board installed and connected to the various conduits. This arrangement greatly reduces the time required for installation. The extra cost of such factory-assembled jobs is usually more than compensated by the saving in the cost of construction labor.

All new mills install the metal clad, factory-assembled switchgear for high voltage circuits. There is practically no exception to this rule. In the greatest majority of cases oil circuit breakers of 500,000 kva interrupting capacity are used due to the growth of the capacity of the power systems in steel mills.

Resistors

Although ventilated motors are fairly common, fan cooled resistors have not been so widely applied. However, some installations recently made would indicate that there is a field for such resistors where space or weight is at a premium, as forced ventilation will reduce the amount of resistor material to approximately one-fourth of that normally required.

There is a place in industry for alloy grid resistance. Some of the characteristics of this resistance are as follows: Non-breakable, non-corrosive, light weight, does not form high resistance joints, and resistance change, due to temperature, is low. The use of this type of resistance is increasing each year.

Development work on the individual control units, such as contactors, relays, masters, and limit switches, goes on continually, and the past year has seen a number of improvements which, while minor in nature, nevertheless result in increased life and reduced maintenance.

MATERIAL HANDLING

Heavy Duty Ram Trucks

With the recent developments in hot and cold strip mills, a larger and much faster type of ram truck has been developed. These trucks, depending upon the size and weight of coils to be carried, are either two or four wheel drive with either power or hand wheel steer. Steering on all four wheels giving short turning radius. Operator controls truck from seat in center of truck. Trucks have been built with capacities up to 16,000 pounds.

As strip mills run twenty-four hours per day, these trucks must be and are built to stand up under tremendous loads and strains to which they are subjected. In one recent installation, three of these ram trucks each operated 160 hours per week and each handled a total of 50 tons of strip steel per hour.

Another type heavy duty four wheel drive, eight wheel steer, 16,000 pounds capacity, high lift ram truck has been marketed this year. This truck was also developed to handle coils of strip steel, up to 76 inches wide and with a maximum weight of 16,000 pounds on a ram extending over the end of the machine. Due to the truck's flexibility, manueverability, and low cost of operation, this method of handling coils is becoming very popular.

In designing the latter truck, particular attention was given to traction and rubber tire capacity, without sacrificing maneuverability. Therefore a drive unit complete with its own motor was placed in the front

end of the rear articulating axle and another on the rear end of the front articulating axle. In this way traction is assured whether the truck is empty or loaded. The wheel tread of these drive wheels is less than the trailing wheel tread on either end of the machine, so as to facilitate steering. Each wheel is equipped with 22 inch diameter by 8 inches wide tire and eight wheels, all of which steer, are used to obtain a maximum amount of rubber. This machine is also made with tilting uprights.

Tractors

Now added to the line of trucks is a heavy duty four-wheel drive tractor, having a rated draw-bar pull of 3500 pounds. Overall length of tractor is 98¾ inches and width 49 inches. Being four-wheel steer, this truck turns intersecting aisles 70 inches wide. Tractor weighs 7000 pounds. This tractor is especially adapted to the hauling of extra heavy loads on trailers over long distances in the steel mill. Because of the weight of this tractor it has plenty of traction on smooth wet floors and due to its full spring suspension affords better riding on rought roadways. Tractor may be equipped with either battery or Ready-Power unit.

Incorporated in the design is a fully enclosed travel controller with carbon to copper circuit breaker and dynamic brake. Brake on drive shaft gear is operated by both foot pedal and operators' seat. As operator leaves seat the brake is set. The drive motor has an overload capacity of 500 per cent so that when stopped on ramp with brake on, motor may be given full load starting current before releasing brake. No fuses are used.

Platform Trucks

Platform trucks for handling strip steel in coils at one of the country's largest plants in the Chicago district have been put in service, with a capacity of 40,000 pounds, each of which will handle coils to a maximum width of 76 inches.

Cranes

One crane builder reports having made radical improvements in the design of plain bearings and that many of these bearings have been in use for more than a year and are giving very good satisfaction. The new bearings are designed with oil seals to prevent any loss of oil and are also provided with reservoir which keeps the bearing supplied with lubricant. Some of the advantages of these bearings are—prevention of oil leaks, retainment of the oil supply, thereby minimizing the amount of oil and service required. The frequency of renewal of lubricant is comparable to that of anti-friction bearings and it makes an ideal application for the one-shot system. The use of alloy steels is being made for certain structural members with the resultant effect of reducing weight and giving a more dependable safety factor.

Manipulators

An all welded manipulator was built for use in connection with a 44″ Blooming Mill in the Pittsburgh district. This is said to be the first all welded unit in this country and the fact that it is hydraulically operated makes it still more unusual. In the description of this manipulator considerable emphasis has been placed on the cushioning effect of the hydraulic control. This manipulator will handle ingots weighing up to 25,000 pounds.

Magnetic Separation of Black Sheets

A magnetic sheet separator in which there is the combined use of a sledging process and a lifting magnet has been developed. The speed at which the sheets are separated manually depends on the temperature at which they have been annealed. A high annealing heat, which is regarded as desirable, causes an increase in the number of "stickers" and slows manual operation.

The recently developed sheet separator consists of a 29½ inch lifting magnet and a 25 cycle, AC. Synthron hammer which has a rounded plunger which protruded through the center of the magnet. The magnet and hammer are carried on a tripod. Cables that supply current for the magnet and hammer extend from the cab of the crane that handles the separating unit. The magnet has a curved V-shaped working face, the center being about one inch out of line with the outer edges.

In operating the separator the crane man lowers the magnetic unit down on the surface of a pile of sheets until the hammer head rests on the sheet. Then he operates the hammer for perhaps a half minute. After the sheets are partially loosened by the blows of the hammer the operator lifts the magnet about one-half inch, turns the current on and off, the special control making possible quick lift and quick drop. Then the separator is raised to about one and one-half inches above the pile and the current is again turned on and off rapidly, resulting in a further loosening of the sheets. The energizing of the magnet is usually repeated at about two and one-half, three and three and one-half inches above the pile. After these operations it is stated that more than 95 per cent of the sheets are completely separated and a further repetition of the process results in effecting practically 100 per cent separation.

Sheet Classifiers

The so-called "sheet classifiers" have been used more extensively than ever during the last year. The thickness of the metal is measured by an electric gage, and the sheets are then assorted into several grades of thicknesses, the entire control being automatic and acting as a function of the electric gage.

PRESSURE COMPENSATORS, TEMPERATURE CONTROL AND RECORDING DEVICES

Automatic Pressure Compensator

In measuring the flows of compressible fluids such as steam, air and gas, variations in the static pressure of the flow directly influence the flow reading. To prevent errors from this source, one of the instruments

builders has developed the Automatic Pressure Compensator for their flow meters.

It is merely a simple spiral pressure tube connected to a lever and as the line pressure changes, the spiral adjusts the multiplication of the linkage between the float and pen arm. This is not an additive correction but a percentage correction; the linear amount of correction differs at different points of the chart and is calibrated to fit the flow formula of the meter. Thus a continuous, instantaneous and accurate compensation for pressure changes is obtained automatically. The Pressure Compensator is sensitive, and will correct the position of the flow pen for a change in pressure as small as one-tenth of one per cent.

Pyrometer

The development of an automatic optical pyrometer has been one of the outstanding developments along this line during the year. One instrument company has successfully applied approximately thirty of these in steel mill operation to measure the temperatures of sheets, rails, billets, ingots, and even rods less than one-fourth inch in diameter. The freedom of this device from errors due to voltage fluctuations, and its extreme speed, make it an interesting pyrometer development for the year.

Air Operated Control

The introduction of air operated control in the steel industry is also an outstanding development. A further development has been the use of amplifying pilot valves, located at the valves proper, which have greatly increased the reliability of air control due to the fact that these amplifying units make it possible to apply full power on the valves even for very small motions.

Temperature Control

The year has seen the application of temperature control on a number of different installations heretofore considered impracticable. Among these have been soaking pits, slab furnaces and open hearth furnaces. In connection with the latter, the application of roof temperature control into the further development of furnace temperature control, is still going on.

During the year automatic temperature control was applied to a very large number of annealing covers. It is estimated that two hundred and fifty such furnaces were equipped with this automatic temperature control.

The control of furnace pressures throughout the steel plant, but in particular in the open hearth department, has received renewed emphasis, and a number of large plants have established a very definite policy that all open hearth furnaces must be equipped with pressure controllers.

CO_2 Recorder

A change in the method of measuring CO_2 will be of interest to the power plant engineer. By passing flue gas saturated with water vapor through a glass measuring cell, the maintenance of dryers and inaccuracy due to corrosion are eliminated.

Thermotube

For temperature measurements of reheating, high-speed steel, forge and similar high-temperature furnaces, a special thermotube has been placed on the market. Compact and reliable, it is particularly adaptable for use with closed-end tubes, being sighted on the inside of the closed end. This constitutes a piece of equipment similar in size and convenience to a standard thermocouple. It replaces platinum thermocouples when their maintenance is too costly, or where gases contaminate the couple so that they go off calibration.

The thermotube is being used quite successfully to measure temperatures of the checker brick in the hottest section of the checker chambers and when temperatures of work in process are required, as on the finishing stands of hot strip mills or roughing stands of rod mills, the thermotube is used with a recorder. Temperature readings are obtained in two seconds or less, while the steel is being processed, without any delay in production.

A thermotube has also been developed for measuring low temperatures, down to 650° F., for rolls, annealing and general heat-treating.

INDUSTRIAL HEATING

Atmosphere Controlled Equipment

The use of controlled atmosphere furnaces has increased rapidly, and the majority of applications of furnaces made during the year are furnaces provided with this equipment.

The development of equipment for processing available gases to give a gas suitable for a protective atmosphere at low cost has been responsible for the rapid development of atmosphere controlled furnaces.

During this year, many improvements have been made in the atmosphere controller for processing city gas, natural gas, propane or butane. One such controller has an output rating of 4000 cubic feet of protective atmosphere gas per hour. In this equipment, the analysis of the output gas can be varied over a considerable range by varying the ratio between the amount of air and gas. The atmosphere controller is provided with visual flowmeters for indicating the volume of air and gas, and a motor-driven air-gas mixer for properly mixing the air and gas before it enters the processing chamber.

Annealing and Normalizing Furnaces

The annealing of wide auto body sheet in coil form has become of great importance due to the rapid introduction of continuous cold rolling mills and the demands of the trade for this material in coil form. For this purpose, the cylindrical electric bell type furnace with fan type base and center heating element has proved exceptionally well adapted. One installation consists of a battery of twenty-six such furnaces, each annealing a charge of sixteen tons of twenty gauge

strip, consisting of two coils of 48 inches wide material. The heating cycle runs from eighteen to twenty hours, and the cooling cycle twenty-four to thirty hours. The temperature uniformity is within ± 10° F. at the end of the soaking period, assuring a very uniformly annealed produce suitable for extra deep drawing applications.

For bright normalizing cold rolled auto body sheet, a controlled atmosphere, electric normalizing furnace has been developed. This type of furnace handles the steel in the form of continuous strip, uncoiling at the charging end and recoiling at the discharge end. The steel passes through the furnace without rider sheets, traveling on driven alloy rollers. Heating elements are located above and below the sheet, and the entire furnace is enclosed within a gas tight, welded steel shell. A special atmosphere, prepared from coke oven or natural gas, is supplied, and the material comes from the furnace as bright and clean as it entered. The furnace installed recently normalizes five tons of 20 gauge strip, 48 inches wide per hour, heating to a temperature of 1750° F. and cooling to 250° F. before discharge into the air.

For some applications, such as the bright annealing of copper wire and other copper products, it is necessary to remove the small amounts of sulphur that may be present, and a suitable sulphur removing equipment has been developed.

Brazing Furnaces

The use of the electric furnace brazing process for the copper brazing of steel parts has increased rapidly and several types of furnaces have been developed to handle both small and large production. These types of furnaces consist of the box type, mesh belt conveyor, roller hearth, etc.

This process has been applied to the brazing of such parts as the all-metal radio tubes, typewriter and similar business machine parts, refrigerator parts, fin type radiators, automotive parts, etc. Each application has shown a lower cost of fabricating, increased strength, and improved appearance.

One recent typical installation consists of a mesh belt conveyor furnace having a conveyor eight inches wide, seven feet long heating chamber, and provided with a water-jacketed cooling chamber. The furnace is rated 41 KW. and is used for the copper brazing of all metal radio tube parts.

Heat Treating Furnace

Another interesting installation consists of two rectangular bell-type furnaces equipped with loading cars, quenching tank, handling crane and control equipment. This installation is for the heat treatment of alloy steel bar stock, thirty feet long. The equipment is designed for operation on several heat treating cycles, among which are hardening, normalizing, annealing, drawing, etc.

The two furnaces, each rated 600 KW., are located near each other, with the quenching tank located between the runout tracks. The handling of the bars is completely automatic as well as the operation of furnaces and furnace cars.

The control equipment is provided with a master control switch, where the heat treating cycle is selected and then the complete cycle of operation is carried out automatically from the point where the steel bars are brought into the heat treating room to the point where they are to be placed after heat treatment.

The production of this equipment is from approximately thirty to one hundred tons per day, depending upon the heat treating cycle and the size of the bars.

Induction Furnaces

Considerable experimental work has been done in connection with the operation of induction furnaces in Germany and as a result it is claimed that the cost of producing more than 3500 tons of steel in a four ton furnace compares favorably with the cost of operating the electric furnaces.

LUBRICATION

There has been a steady increase in the understanding of the function of extreme pressure lubricants and the part that sulphur, chlorine, lead and some few other compounds play in them. Further, the study of the load-carrying, anti-weld and oiliness characteristics of oils has helped to better understand the working of cutting fluids.

A number of new products have been added to the line of wire rope compounds, including several which have external hardening qualities, making them particularly suitable for relubricating elevator ropes externally. The development of special core compound to be built into the fibrous wire rope centers has been carried into the field. Centers impregnated with this core compound have been built into various types of wire ropes and put into the field for test. Still another development in connection with wire ropes is the pneumatic system for building the wire rope compound and wire rope center compounds into the wire rope strands and wire rope centers during the process of manufacture.

One manufacturer has concentrated in particular on the development and perfection of grades for the lubrication of machinery equipped with ball or roller bearings. Working in co-operation with the leading engineers in the ball and roller bearing field, they have developed lubricants which it is reported will overcome the recognized drawbacks of ordinary greases and enable bearings to function most efficiently, while safeguarding them from premature deterioration and assuring their long life. The increasingly large application of anti-friction bearings to the iron and steel industry justifies the special attention that has been given to the development of non-fluid oils for their lubrication.

CARBON BRUSHES

The past year has witnessed the application of a new series of electro-graphitic brushes on motors and generating equipment in the iron and steel industry. It is the products of an elaborate program of research in the course of which the basic factors affecting brush performance were determined and production methods were developed for making brushes which possess, in

uniformly controlled degree, those characteristics which favorably affect performance.

It is reported that the accurate control of both physical and performance characteristics from lot to lot permits the changing of individual brushes on a machine without fear of selective action or change in operating performance of the machine itself. The graduated but definitely related performance characteristics of the five individual grades of the series represent a decided advantage over any like number of brushes of unrelated properties. It permits a logical grade selection to meet a known combination of service conditions or to correct a known fault.

WELDING

AC. Arc Welders

With the rapid increase of the use of alternating current for arc welding during the past year, new lines of arc welding transformers have been developed. One complete line consists of units with ratings of 150 amperes, 500 amperes, 750 amperes, and 1000 amperes. All but the 150 ampere units have a rated open circuit secondary voltage of 80, with a tap provided for approximately 100 volts. As the voltage of the welding arc varies between approximately 25 and 40 volts, the difference between this value and the full open circuit voltage of the transformers is absorbed in leakage reactance within the transformer. This leakage reactance is used to stabilize, control, and regulate the welding current. It is made adjustable by employing a magnetic shunt between primary and secondary windings. This magnetic shunt is mechanically connected to a hand wheel located on the transformer casing. By turning this hand wheel a range in current adjustment from the full rating of the transformer down to approximately three per cent of this value can be obtained.

Remote control of welding current adjustment is being more generally applied to the single operator type of DC. welding equipment. This auxiliary control includes a small motor for driving the adjusting rheostat on welder set. This motor is controlled by means of a push button located near the electrode holder, connected to the motor through two leads embedded in the welding cable.

Resistance Welder Control Equipment

Great improvements have been made in the Thyratron control equipments for resistance spot welding machines, permitting wider application of this accurate control. The development of the new pool type Thyratron tube, which will handle directly primary currents up to 2500 amperes without the necessity of interposing a series transformer, has greatly simplified these control equipments and resulted in a considerable decrease in cost. The equipment is easier to install and maintain because the entire unit is mounted within one compact enclosing case. The controls are easier to adjust because there is only one time adjusting dial and one switch, the dial being calibrated from one to thirty cycles in one cycle steps. The maintenance cost has been greatly reduced because of the decrease in the number of the tubes and the improvement in the control circuit. For example, the control for a 300 kva spot welder now includes only six tubes, compared with the former Thyratron control panel of this same capacity having a total of thirteen tubes, and needing in addition a series transformer.

Sequence Control Panel for Hydraulically Operated Spot Welders

In making a weld with a spot welder a certain sequence of operation must be followed. First, the electrodes must be lowered onto the work and full pressure applied. Then the welding current must be caused to flow for the desired time, and after this has stopped the pressure must be relieved so that the electrodes will raise and permit the work to be removed. After the operator presses an initiating switch, the control energizes a solenoid valve on the welding machine, applying pressure to the electrode. After sufficient time delay to permit the pressure to build up to the maximum desired value, the signal will automatically be given to the Thyratron control to pass the welding current through the electrodes. As soon as the current stops, the sequence control will immediately de-energize the solenoid valve, releasing pressure from the electrode and making the machine ready for another weld. The main feature of this control is that it permits the maximum possible speed of operation of a pneumatically or hydraulically operated spot welder because it immediately releases the pressure upon completion of the current flow.

Ampere-Seconds Indicator

A special ampere-seconds indicator has been developed for use with spot welding machines when it is desired that the operator be warned in the event the time of current flow for making a weld, or the voltage or current for any one weld varies an appreciable amount. In the construction of this device a standard ammeter is modified to include a light source, a mirror, and a phototube so arranged as to operate a relay when an impulse of power causes the meter to deflect to the mid-point on the scale. To make this deflection a definite number of amperes for a definite length of time is required. In other words, this means a definite number of ampere-seconds. When the meter reaches the mid-point of the scale it reflects the light to the phototube, which in turn causes the relay to energize the magnet of a gong. In the event either the time or current is insufficient, the ammeter will not reach the mid-point and the gong will not sound. If the time or current is excessive, so that the number of ampere-seconds supplied to the welder is greater than that for which the device is adjusted, the meter will deflect beyond the mid-point, causing the gong to sound both on the upswing and the down swing. A potentiometer is supplied to permit adjustment of the meter to the mid-point deflection for any value of ampere seconds within the range of the equipment.

strip, consisting of two coils of 48 inches wide material. The heating cycle runs from eighteen to twenty hours, and the cooling cycle twenty-four to thirty hours. The temperature uniformity is within ± 10° F. at the end of the soaking period, assuring a very uniformly annealed produce suitable for extra deep drawing applications.

For bright normalizing cold rolled auto body sheet, a controlled atmosphere, electric normalizing furnace has been developed. This type of furnace handles the steel in the form of continuous strip, uncoiling at the charging end and recoiling at the discharge end. The steel passes through the furnace without rider sheets, traveling on driven alloy rollers. Heating elements are located above and below the sheet, and the entire furnace is enclosed within a gas tight, welded steel shell. A special atmosphere, prepared from coke oven or natural gas, is supplied, and the material comes from the furnace as bright and clean as it entered. The furnace installed recently normalizes five tons of 20 gauge strip, 48 inches wide per hour, heating to a temperature of 1750° F. and cooling to 250° F. before discharge into the air.

For some applications, such as the bright annealing of copper wire and other copper products, it is necessary to remove the small amounts of sulphur that may be present, and a suitable sulphur removing equipment has been developed.

Brazing Furnaces

The use of the electric furnace brazing process for the copper brazing of steel parts has increased rapidly and several types of furnaces have been developed to handle both small and large production. These types of furnaces consist of the box type, mesh belt conveyor, roller hearth, etc.

This process has been applied to the brazing of such parts as the all-metal radio tubes, typewriter and similar business machine parts, refrigerator parts, fin type radiators, automotive parts, etc. Each application has shown a lower cost of fabricating, increased strength, and improved appearance.

One recent typical installation consists of a mesh belt conveyor furnace having a conveyor eight inches wide, seven feet long heating chamber, and provided with a water-jacketed cooling chamber. The furnace is rated 41 KW. and is used for the copper brazing of all metal radio tube parts.

Heat Treating Furnace

Another interesting installation consists of two rectangular bell-type furnaces equipped with loading cars, quenching tank, handling crane and control equipment. This installation is for the heat treatment of alloy steel bar stock, thirty feet long. The equipment is designed for operation on several heat treating cycles, among which are hardening, normalizing, annealing, drawing, etc.

The two furnaces, each rated 600 KW., are located near each other, with the quenching tank located between the runout tracks. The handling of the bars is completely automatic as well as the operation of furnaces and furnace cars.

The control equipment is provided with a master control switch, where the heat treating cycle is selected and then the complete cycle of operation is carried out automatically from the point where the steel bars are brought into the heat treating room to the point where they are to be placed after heat treatment.

The production of this equipment is from approximately thirty to one hundred tons per day, depending upon the heat treating cycle and the size of the bars.

Induction Furnaces

Considerable experimental work has been done in connection with the operation of induction furnaces in Germany and as a result it is claimed that the cost of producing more than 3500 tons of steel in a four ton furnace compares favorably with the cost of operating the electric furnaces.

LUBRICATION

There has been a steady increase in the understanding of the function of extreme pressure lubricants and the part that sulphur, chlorine, lead and some few other compounds play in them. Further, the study of the load-carrying, anti-weld and oiliness characteristics of oils has helped to better understand the working of cutting fluids.

A number of new products have been added to the line of wire rope compounds, including several which have external hardening qualities, making them particularly suitable for relubricating elevator ropes externally. The development of special core compound to be built into the fibrous wire rope centers has been carried into the field. Centers impregnated with this core compound have been built into various types of wire ropes and put into the field for test. Still another development in connection with wire ropes is the pneumatic system for building the wire rope compound and wire rope center compounds into the wire rope strands and wire rope centers during the process of manufacture.

One manufacturer has concentrated in particular on the development and perfection of grades for the lubrication of machinery equipped with ball or roller bearings. Working in co-operation with the leading engineers in the ball and roller bearing field, they have developed lubricants which it is reported will overcome the recognized drawbacks of ordinary greases and enable bearings to function most efficiently, while safeguarding them from premature deterioration and assuring their long life. The increasingly large application of anti-friction bearings to the iron and steel industry justifies the special attention that has been given to the development of non-fluid oils for their lubrication.

CARBON BRUSHES

The past year has witnessed the application of a new series of electro-graphitic brushes on motors and generating equipment in the iron and steel industry. It is the products of an elaborate program of research in the course of which the basic factors affecting brush performance were determined and production methods were developed for making brushes which possess, in

uniformly controlled degree, those characteristics which favorably affect performance.

It is reported that the accurate control of both physical and performance characteristics from lot to lot permits the changing of individual brushes on a machine without fear of selective action or change in operating performance of the machine itself. The graduated but definitely related performance characteristics of the five individual grades of the series represent a decided advantage over any like number of brushes of unrelated properties. It permits a logical grade selection to meet a known combination of service conditions or to correct a known fault.

WELDING

AC. Arc Welders

With the rapid increase of the use of alternating current for arc welding during the past year, new lines of arc welding transformers have been developed. One complete line consists of units with ratings of 150 amperes, 500 amperes, 750 amperes, and 1000 amperes. All but the 150 ampere units have a rated open circuit secondary voltage of 80, with a tap provided for approximately 100 volts. As the voltage of the welding arc varies between approximately 25 and 40 volts, the difference between this value and the full open circuit voltage of the transformers is absorbed in leakage reactance within the transformer. This leakage reactance is used to stabilize, control, and regulate the welding current. It is made adjustable by employing a magnetic shunt between primary and secondary windings. This magnetic shunt is mechanically connected to a hand wheel located on the transformer casing. By turning this hand wheel a range in current adjustment from the full rating of the transformer down to approximately three per cent of this value can be obtained.

Remote control of welding current adjustment is being more generally applied to the single operator type of DC. welding equipment. This auxiliary control includes a small motor for driving the adjusting rheostat on welder set. This motor is controlled by means of a push button located near the electrode holder, connected to the motor through two leads embedded in the welding cable.

Resistance Welder Control Equipment

Great improvements have been made in the Thyratron control equipments for resistance spot welding machines, permitting wider application of this accurate control. The development of the new pool type Thyratron tube, which will handle directly primary currents up to 2500 amperes without the necessity of interposing a series transformer, has greatly simplified these control equipments and resulted in a considerable decrease in cost. The equipment is easier to install and maintain because the entire unit is mounted within one compact enclosing case. The controls are easier to adjust because there is only one time adjusting dial and one switch, the dial being calibrated from one to thirty cycles in one cycle steps. The maintenance cost has been greatly reduced because of the decrease in the number of the tubes and the improvement in the control circuit. For example, the control for a 300 kva spot welder now includes only six tubes, compared with the former Thyratron control panel of this same capacity having a total of thirteen tubes, and needing in addition a series transformer.

Sequence Control Panel for Hydraulically Operated Spot Welders

In making a weld with a spot welder a certain sequence of operation must be followed. First, the electrodes must be lowered onto the work and full pressure applied. Then the welding current must be caused to flow for the desired time, and after this has stopped the pressure must be relieved so that the electrodes will raise and permit the work to be removed. After the operator presses an initiating switch, the control energizes a solenoid valve on the welding machine, applying pressure to the electrode. After sufficient time delay to permit the pressure to build up to the maximum desired value, the signal will automatically be given to the Thyratron control to pass the welding current through the electrodes. As soon as the current stops, the sequence control will immediately de-energize the solenoid valve, releasing pressure from the electrode and making the machine ready for another weld. The main feature of this control is that it permits the maximum possible speed of operation of a pneumatically or hydraulically operated spot welder because it immediately releases the pressure upon completion of the current flow.

Ampere-Seconds Indicator

A special ampere-seconds indicator has been developed for use with spot welding machines when it is desired that the operator be warned in the event the time of current flow for making a weld, or the voltage or current for any one weld varies an appreciable amount. In the construction of this device a standard ammeter is modified to include a light source, a mirror, and a phototube so arranged as to operate a relay when an impulse of power causes the meter to deflect to the mid-point on the scale. To make this deflection a definite number of amperes for a definite length of time is required. In other words, this means a definite number of ampere-seconds. When the meter reaches the mid-point of the scale it reflects the light to the phototube, which in turn causes the relay to energize the magnet of a gong. In the event either the time or current is insufficient, the ammeter will not reach the mid-point and the gong will not sound. If the time or current is excessive, so that the number of ampere-seconds supplied to the welder is greater than that for which the device is adjusted, the meter will deflect beyond the mid-point, causing the gong to sound both on the upswing and the down swing. A potentiometer is supplied to permit adjustment of the meter to the mid-point deflection for any value of ampere seconds within the range of the equipment.

A New DC. Welding Generator

An improved and simplified DC. welding generator has been developed during the past year. By using adjustable iron shunts around the armature instead of shunt field coils, the total number of field coils is reduced from eight or ten to four. Meters, reactors, resistors and exciters are eliminated. The proper welding current can be selected in advance by a handwheel, the current for a given setting showing on a dial. The current is practically constant on the volt-ampere curve during transient changes. The open circuit voltage is about half that of the conventional welding generator. Because of its characteristics, it is claimed the new generator gives a faster rate of welding with reduced power consumption.

LIGHTING

Undoubtedly the most outstanding contribution to the illumination of mills has been the use of the High Intensity Mercury Vapor Lamp. This is the first real improvement in illumination since the advent of the high voltage gas filled Mazda lamps some twenty years ago. This lamp is now furnished in two sizes, 400 Watt and 250 Watt. The lumen output of the 400 Watt unit exceeds that of the 750 Watt incandescent lamp which has a rated output of 14,550 lumens. The 250 Watt unit has a lumen output approximately halfway between the ordinary 300 and 500 Watt incandescent lamps.

As the name implies they are mercury type lamps and the color quality of the illumination is similar yet somewhat whiter than the well known Cooper Hewitt vapor lamp.

In combination with Mazda lamps this lamp provides excellent illumination for color matching and is an ideal unit for inspection purposes.

The length of life of the lamp units appears to be increasing with the improved processes of manufacture of these units and is well above the Mazda lamps.

The type of reflector used varies somewhat with the different manufacturers but the totally enclosed unit has certain inherent advantages in most locations over the ventilated reflectors.

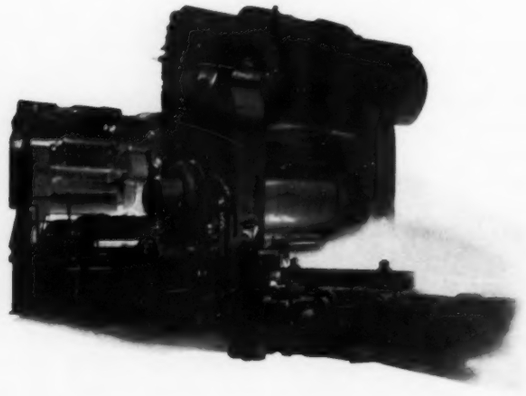
The use of the Alzak finishing process for aluminum reflectors is very general and is recognized as one of the best reflecting surfaces in that it provides a permanence and durability not found in many other commercial reflectors.

CONCLUSION

Each year the contribution made to this association by the members of this Developments Committee becomes greater, and only those in close contact with this work can appreciate the efforts which they put forth.

As chairman of the committee, I consider it a real honor to be associated with these engineers and have a part in arranging this information in the form of an Annual Report.

What the future holds for us, time only can tell and it is a wise Providence that so shields us. The Association has undergone a number of important changes during the past year and it is sincerely hoped that these changes will make it possible to fill even more effectively than ever before the place it holds in the steel industry and that the coming year will prove to be one in which we can serve this industry as is truly befitting such an organization.



Annealing and Normalizing

Auto Body Steel in Electric Furnaces

By F. T. HAGUE,
D.C. Generator Engineering
and P. H. BRACE,
Consulting Metallurgist, Research Laboratories
WESTINGHOUSE ELECTRIC & MFG. CO.

Paper to be presented before the A. I. & S. E. Convention, Detroit, September 22-25, 1936.

1. Outline of Problem

Normalizing and annealing are two approaches to the problem of heat treating cold rolled sheet to put it in suitable condition for pressing operations. The final operation in making auto body sheet is a cold rolled reduction in thickness of approximately 50%, which leaves the steel hard and comparatively non-ductile. To give this steel the combination of softness and ductility most favorable for deep drawing, the steel supplier has the alternatives of using a continuous normalizing process of less than 10 minutes or a bell annealing process of 48 to 120 hours.

Each process is established in commercial manufacture, ultimately permitting a comparison of characteristics beyond those indicated by studies in research laboratories. Each process at this stage of development produces steel with different characteristics, both suitable in varying degrees to the common requirement of deep drawing. Bright bell annealing enters this comparison at the crest of a long and successful development, showing its metallurgical possibilities have been substantially indicated. Continuous bright normalizing appears to be at the threshold of its development, and from the research standpoint its ultimate metallurgical and processing possibilities are only generally indicated. This paper deals largely with the present status of bell annealing and the initial findings of a normalizing research program without any attempt at long range prediction of ultimate possibilities.

2. Nature of Auto Body Steel

(a) Chemical Composition

Auto body steel is plain low carbon steel made in basic open hearth furnaces at low cost. Approximately 50% of the metal charge is steel scrap, which introduces measurable amounts of residual metals, among which manganese, copper, nickel and chromium are prominent. The steel is cast in ingots weighing 15 tons or more and in such condition that "rimming" or gas evolution takes place during freezing, giving rise to a flat topped ingot 80% to 90% of which is usable for auto body stock. This may be compared with the more expensive "killed" steels, which freeze without gas evolution and give ingots free from porosity but have axial shrinkage cavities or pipes which reduce the usable material.

A typical ladle analysis of rimmed steel might be as follows:

Carbon	Up to 0.08%
Manganese	0.30 to 0.45
Sulphur	Less than .040
Phosphorus	Less than .030

The mean composition of the resulting sheet material exhibits considerable variance, as shown:

	Percent	Percent Variance Based on Lower Amount
Carbon	0.030—0.060	100
Manganese	0.30 —0.40	33
Phosphorus	0.005—0.014	200
Sulphus	0.012—0.030	150
Silicon	0.001—0.005	400
Nickel	0.03 —0.06	100
Copper	0.02 —0.05	150
Chromium	0.02 —0.05	150

From this it will be evident that auto body sheet does not have a fixed chemical composition and that considerable variance in its response to heat treatment may be expected.

(b) Identification in Ingot

In addition to variance of mean composition, there are local variations within ingots due to segregation and chemical changes resulting from rimming action, which may produce a 4 to 1 ratio of carbon content and a practically carbonless peripheral zone. These composition variables gave rise to a wide scatter in ductility and hardness which was quite baffling until the situation was clarified by identification of the steel with respect to its location in the original ingot and with its chemical analysis. It was then apparent that coils made from different portions of an ingot may give widely different annealed properties and that they might have widely different chemical analyses. With a knowledge of the probable dispersion within an ingot and the effect on physical properties of variations of carbon, manganese, sulphur, chromium, etc., it became possible analytically to study the results of a given annealing or normalizing cycle. Such knowledge is indispensable to a study of the problem because differ-

F. T. HAGUE

P. H. BRACE

ences due to variations of heating and cooling cycles are generally of equal or smaller magnitude than changes in properties due to actual differences in the steel when considering annealing, whereas our later work suggests that it may become practical to control the normalizing cycle to suit the chemistry of the steel to produce a smaller spread of physical properties than obtainable through annealing.

(c) Users' Requirements

The user of auto body stock has easy, medium and deep draw applications and it is not a requirement of the annealing process that all the product meet some difficult deep draw test. Under the best conditions of bell annealing, a variation of 20 points Olsen is frequently met with on coils from a single ingot and a range of 40 points can be expected over a range of ingots from different suppliers. Thus, it will be seen that a commercial grade of "rimmed" ingot steel forms a reasonably satisfactory raw material for the manufacture of auto body stock so long as a reasonable percentage of deep and medium draw stock is produced.

(d) Hot and Cold Mill Practice

Each supplier of cold rolled steel has a well developed process for his guidance in both hot and cold mill rolling that he has found to produce a product of good deep drawing characteristics. It is generally recognized that temperature control throughout the length of the hot mill, including the cooling bed, is being utilized to produce an improved product and control grain structure in a desirable way. Similarly, in the cold mills quality can be controlled by adherence to rigid process specifications.

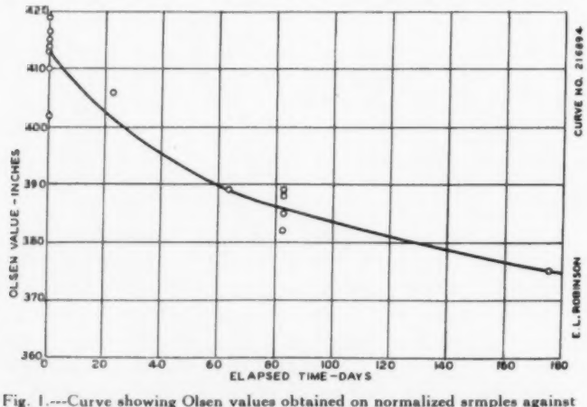


Fig. 1.---Curve showing Olsen values obtained on normalized srmples against the length of time the cold worked samples were kept at the laboratories before normalizing. Research Preferred Cycle---Lot V

(e) Age Hardening Cold Rolled Stock

The makers of sheet steel well know that it hardens and loses its ductility over a period of months from the time of last cold reduction. The effect of such age hardening upon the maximum ductility obtainable after normalizing was investigated after difficulty was encountered early in this investigation in securing consistent results. On each lot of steel tested, the Olsen values developed by any particular normalizing cycle were higher when the steel was normalized and tested within a few days after receipt at the laboratories than when normalized after a lapse of some months, and immediately tested. These data (Fig. 1) were compiled from tests on only three different steel shipments and are shown as indications of a trend of age hardening characteristics rather than as final data applicable to all cold rolled steel. The importance of recognizing this characteristic is obvious in developing the maximum ductility by normalizing. The cold rolled steel should apparently be normalized within two weeks of cold rolling; otherwise a serious loss of possible ductility may be experienced. All testing samples should be dated when cold rolled; otherwise, the possibilities of obtaining good ductility may be masked by the age-hardening characteristic.

The work of Davenport and Bain has indicated that aging is probably due to the precipitation of stable compounds, presumably oxides, which appear at the grain boundaries and at the slip planes. To quote from their published work: ". . . . . In strain aging, a most unusually wide range of temperatures will cause practically maximum hardening without subsequent softening, even at a time interval of 500 or 1000 hours". Again, in the summary: ". . . . . the compound forms from the iron and the other element in super-saturated solid solution, (1) at rather low temperature, (2) only at interfaces (grain boundaries or slip planes). The particles do not grow to ineffecually large size at the expected temperatures because (3) of low diffusion rate and perhaps unusual stability of the first crystallites . . . . . ".

The compound causing the effect is believed to be an oxide or oxides. Whether or not finely dispersed oxide particles precipitated from solid solution can survive without a re-solution treatment of one minute at 1750° F., is a question to which we have no positive answer, although it may be considered possible, inasmuch as we have never detected, in ferrous alloys, any appreciable dissolving of visible non-metallic inclusions known to be oxides under the influence of heat treatments of the sort described here. Assuming that the oxides precipitating after cold rolling are not completely re-dissolved by holding the aged steel for one minute at 1750° F., the apparent anomalies in the Olsen values obtained after normalizing stock of different ages, are plausibly explained.

(f) Iron-Carbon Diagram

A knowledge of the constitution of steel as distinguished from its composition, is a key to many of the problems of annealing and normalizing. The equilibrium diagram, Fig. 2, based on the assumption that temperature changes take place very slowly, shows that, in pure iron at 1650° F., a change takes place in the arrangement of the atoms within the crystals, accompanied by an absorption of heat and profound changes in physical properties; that is, there are two varieties of iron, one stable up to approximately 1650°F. and known as alpha iron or ferrite, and another stable above approximately 1670° F. and known as gamma iron or austenite.

One of the outstanding differences between alpha iron and gamma iron is that alpha iron is capable of dissolving no more than approximately 0.03% carbon while gamma iron at 1670° F. can hold in solid solution approximately 1.2%. On this difference and the fact that a given temperature determines which iron can exist, hinges the art of heat-treating steel.

Referring to Fig. 2, the line ABD shows that the presence of carbon in solid solution in gamma iron lowers the temperature at which alpha iron begins to form. Assume that a gamma iron carbon solid solution containing 0.05% carbon is allowed to cool slowly through the temperature corresponding to the intersection of the carbon ordinate with the line ABD. At that point, the previously homogeneous gamma solid solution begins to resolve itself into a mixture of (a) alpha solid solution having a small percentage of carbon $X\alpha$ dissolved in it, and (b) a residual gamma solid solution carrying a much larger percentage of carbon $X\beta$ than the original, because of the low carbon alpha solution which has separated from it.

As the temperature is further lowered, additional alpha solution separates and the residual gamma solution becomes smaller in amount and richer in carbon. When the temperature given by the line CD is passed (approximately 1320° F.) the gamma solution then existing transforms bodily and produces a third constituent, known as pearlite, consisting of an intimate mixture of iron carbide (Fe_3C) and alpha iron. The pearlite may be seen as small dark areas in the micrographs of normalized and annealed steels. At this point the metal consists of a preponderance of alpha solid solution carrying approximately 0.03% carbon and scattered pearlitic regions where the carbon content is approximately 0.9%.

The physical properties exhibited by the steel when it finally reaches normal temperature, after having cooled from the gamma temperature region are largely dependent upon the form, size and distribution of its carbide particles and on the amount of carbon or other components remaining in solid solution. These factors are controllable by heat treatment and it was the object of this investigation to evaluate the effects of various heat treatments.

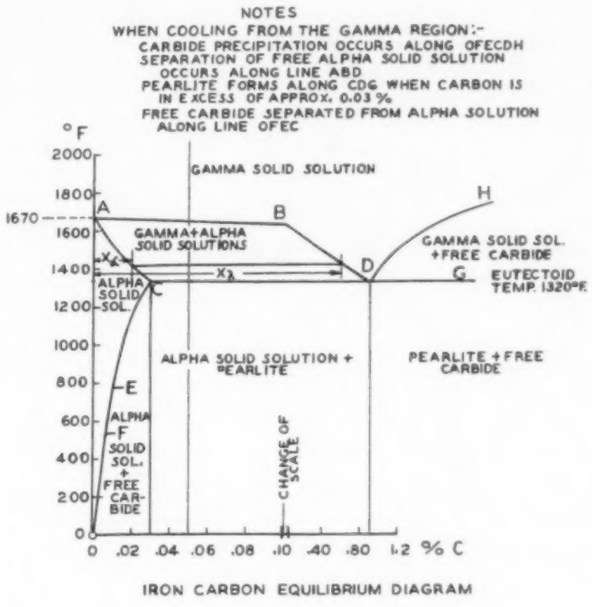


Fig. 2

3. Bell Annealing Furnaces

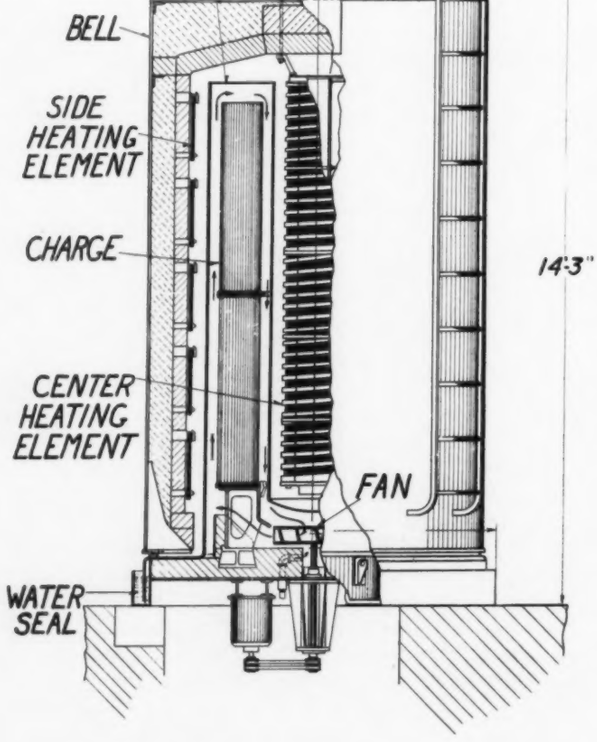
The electric bell annealing furnace has been developed to a high degree of perfection for the bright annealing of auto body sheet in coil form. Figure 3 shows schematically the arrangement of the furnace heating elements and interior details. The bell proper is provided with a rugged center heating element which extends downward into a recess formed into the hoods which cover the charge. The heating element is ribbon wound flatwise around the five porcelains comprising the supports. Rather heavy ribbon is used and the watts dispersion per square inch is kept to a low value, thus assuring long life.

The wall heating elements of the furnace are located completely around the outside of the furnace chamber, supported on porcelain hangers and spacers. Heat is thus supplied all around the outside of the coils, and to the center of the coils as well, assuring much more rapid heating than can be obtained by heating from the outside alone, and at the same time, great uniformity of temperature can be consistently and quickly obtained from top to bottom and within the coil itself. Distortion of coils annealed in this type of furnace is very small due to temperature uniformity.

The furnace base is provided with a cast alloy centrifugal fan for circulating the furnace atmosphere upwards inside the hood and over the outside of the coils

to the top of the inner hood, thence down through the center to the fan. By the use of a high pressure type of blower, active circulation can be set up, thus aiding in heating and cooling as well. This is particularly important as the cooling portion of the cycle is ordinarily the longest part. The charge is supported upon alloy base castings which rest upon steel castings located well down out of the high temperature zone of the base. This arrangement transmits the heavy loads encountered, when supporting a charge of 16 tons in the furnace, to refractories far enough away from the heat that they are able to carry the resultant stresses without premature failure. The base castings are made of several independent pieces locked together by means of lugs but not rigidly bolted into one piece. The purpose of this is to permit free expansion and contraction of these castings under repeated heating and cooling cycles, thus preventing the premature failure which may result when such castings are made in one piece or rigidly bolted together.

Fig. 3. Schematic layout of bell furnace.



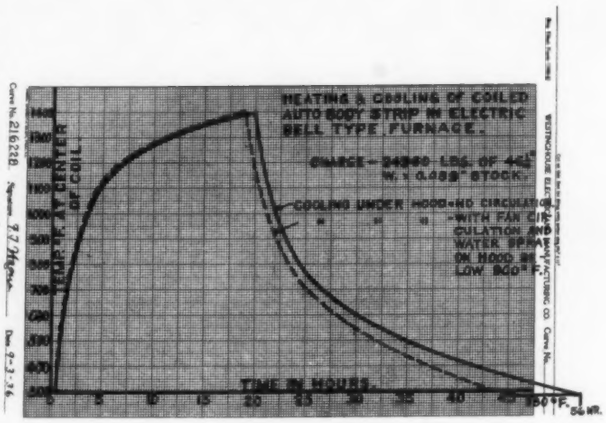


Fig. 4. Typical bell cycle.

The hood or annealing cover is made of either 25% chromium, 12% nickel alloy or 17% chromium alloy, and is provided with a cylindrical doughnut shaped skirt which extends out to the outer circumference of the base where it is immersed in a water seal. This arrangement provides a gas-tight structure whose gas loss is low as compared to covers sealed with sand. It, moreover, eliminates the scrap loss due to sand scratching, which is likely to occur when sand is used as the sealing medium.

Figure 4 shows a typical heating and cooling cycle. The upper curve shows a typical heating cycle and its corresponding cooling cycle as obtained with natural cooling without the use of either fans or a water-cooled hood. This is the type of cycle used in a number of the older installations. The lower curve shows a cycle obtained through the use of the fans during the entire cooling cycle from 1200° down. This curve shows the influence of a water spray on the outside of the hood, as a means of accelerating cooling.

Figure 5 shows a portion of a battery of 26 modern electric bell furnaces installed in the Ford Motor Company's Detroit Plant in 1935. These furnaces take two coils of 48" wide sheet, each coil weighing 16,000 pounds. The coils are loaded on the furnace base with a magnet, after which the inner hood is placed over the two coils, as shown in Figure 6. The hood is then purged with a protective atmosphere of partially combusted coke oven gas and the hot furnace bell lowered over the hooded charge. Figure 7. The receptacle and plug-in arrangements are mounted in pulpits located midway between bell positions. The leads to the furnace are brought out to 3 phase plugs which the operator inserts into receptacles in the pulpit.

4. Research Studies

(a) Experimental Furnace

A research study was started for the purpose of developing a short continuous normalizing cycle for auto body sheet of 19 and 20 gauge. Our studies indicated that the total cycle time should be less than ten minutes to keep the process within competitive range of present annealing practice, based upon using conventional forms of normalizing furnace structure. This work was initially started in 1933, in an experimental

Fig. 5.

electric furnace in our Mansfield Plant. Figure 8. The purpose of this continuous furnace was to demonstrate a system of normalizing which would produce bright work in a controlled atmosphere and to be a proving ground for theories which had formed on the possible results obtainable.

The furnace was small and only small changes could be made in the temperature cycle for which it was designed. Valuable data were obtained on the treatment of the reducing atmosphere required and it was demonstrated that synchronized alloy rolls of commercial surface finish did not scratch a bright steel sheet.

(b) Research Equipment

The metallurgical studies were transferred to our Research Laboratories. During the preliminary investigation a definite need was felt for equipment which would allow the treatment of samples of sheet steel large enough to accommodate several Olsen ductility tests on a single specimen; therefore, an apparatus for the normalizing of large specimens was designed and built. This is shown in Figure 9. The sample 4″ x 36″ was heated by passing an electric current through it and cooled by means of radiation to water-cooled copper plates. Temperature was recorded on a Leeds and Northrup high speed micromax recorder by means of one or more thermo-couples spot-welded to the specimen. Temperature was controlled to produce desired time-temperature cycles by means of push button operated voltage regulators controlling the voltage applied to the specimen. All samples were normalized in a hydrogen protective atmosphere.

In order to eliminate uncertainties due to center-to-edge variance in the quality of the steel over the width of the sheet as received, samples were cut parallel to the direction of rolling of the sheet instead of transversely, and their identities were maintained. The edge of the sheet is almost invariably softer than the center, because the edge is composed of the rolled out low carbon skin produced by the "rimming" action of the original ingot. The ductility tests were run on a new Olsen testing machine.

With the experimental arrangements as outlined, it was possible to obtain four test samples, size 4″ x 4″, from each normalized specimen, and to produce any time temperature cycle desired except one involving a liquid quench. Such an equipment is infinitely more flexible for research purposes than any full size furnace. A thorough check revealed a maximum temperature variation of about 18° F. over the portion of the specimen from which test samples were taken, and the Rockwell and Olsen values on the four samples constituted a check on each other.

(c) Test Program

From a study of a conventional heating and cooling cycle, it was concluded that such a cycle might be divided into four parts for purposes of research, i.e. (1) top temperature, (2) first cooling, (3) shelf—which may cover either a re-heating, a sustained temperature, or a sloping temperature condition, and (4) final cooling. The assigned total cycle time was taken as nine minutes and the problem became one of demonstrating

Fig. 5. Battery of 26 modern electric bell furnaces.

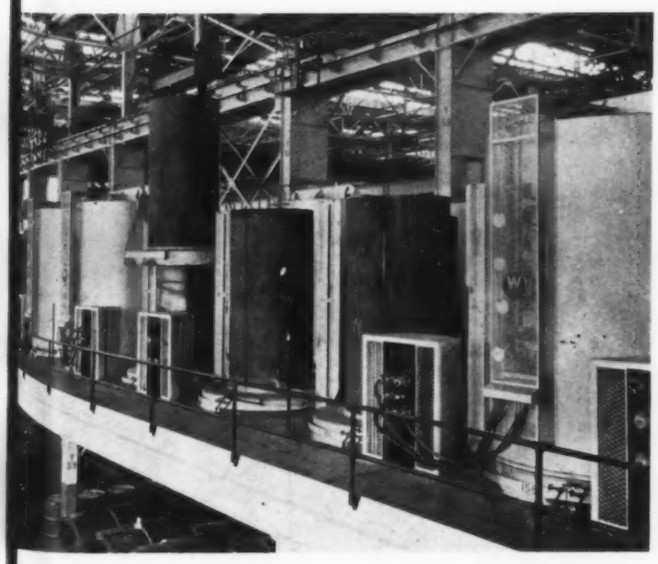
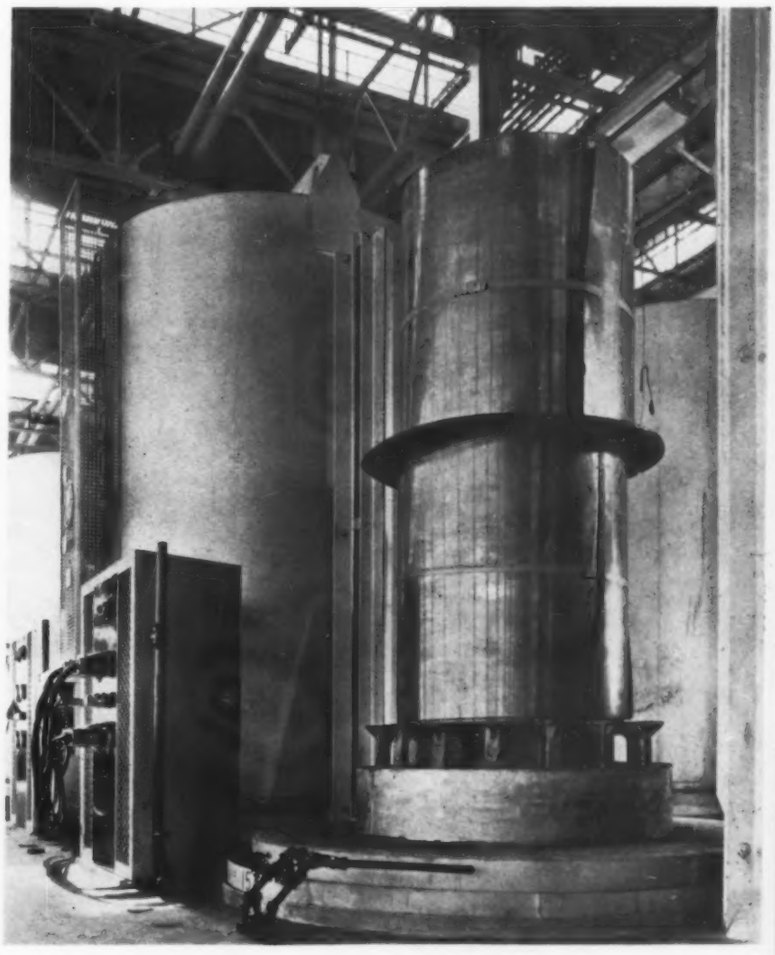


Fig. 6. Inner hood being placed over coils.



what could be accomplished within this time using time temperature cycles reproducable in continuous furnaces of conventional construction.

1. *Top Temperature:* The problem of developing the most advantageous normalizing cycle was approached through consideration of the iron-carbon diagram, Figure 2. Inasmuch as a fine and uniform grain size is desired for ductility reasons, it appeared desirable to use a maximum temperature above the AB line in order to take advantage of the grain refinement which normally occurs when steel is carried through its alpha-gamma transformation. However, the benefits of grain refinement may be lost as a result of the tendency of rapid grain growth that becomes manifest when temperatures much above AB are used. Previous work had led to the impression that an elapsed time of one minute at maximum temperature produced results as good as could be obtained by longer exposure, and in view of the fact that the heating end of commercial furnaces of the continuous type absorbs most of the cost, it was thought best to limit the time at top temperature to one minute in the experimental work.

The preliminary work had indicated that, with top temperatures below the critical point (1680° F.), it was not possible to get as consistently good results for hardness and ductility as with top temperatures above this point. The investigation of top temperature effects was conducted by choosing a cooling routine known to give good results for hardness and ductility and applying various top temperatures while holding the remainder of the cycle constant. The results of this series are shown in Figure 10. From the curve it is indicated that optimum results were obtained with top temperatures from 1725-1760° F., the important point being to use a temperature of at least 1715° F.

2. *First Cooling Chamber Conditions:* At the end of the first heating phase of the cycle there exists a nearly homogeneous solution of carbon in gamma iron and the next step is to cool it to the shelf temperature condition at a rapid rate. Various experiments were made on cooling rates from a slow cool to a liquid quench. The quench put the material in such condition that it did not respond properly to the subsequent phases of heat treating. The maximum obtainable rate of cooling with re-circulated atmosphere of approximately 500° F. per minute brought the material down to a desirable shelf temperature within two minutes and our work showed no benefit of a slower cooling rate.

3. *Shelf Chamber Conditions:* The first cooling chamber delivered the steel to the shelf phase with most of the carbon in solid solution in the ferrite and the problem was then to cause this carbon to precipitate in the least harmful form with the least expenditure of time. Referring again to Figure 2, the line CEF indicates decreasing solubility of carbon in ferrite with decreasing temperature. The diagram represents equilibrium conditions attained by very slow cooling. With the rates involved in a practicable normalizing operation, the carbon actually in solution is, in general, in excess of equilibrium quantity at any temperature. Moreover, as the temperature falls, the rate of precipi-

Fig. 7. Hot furnace bell being lowered over the hooded charge.

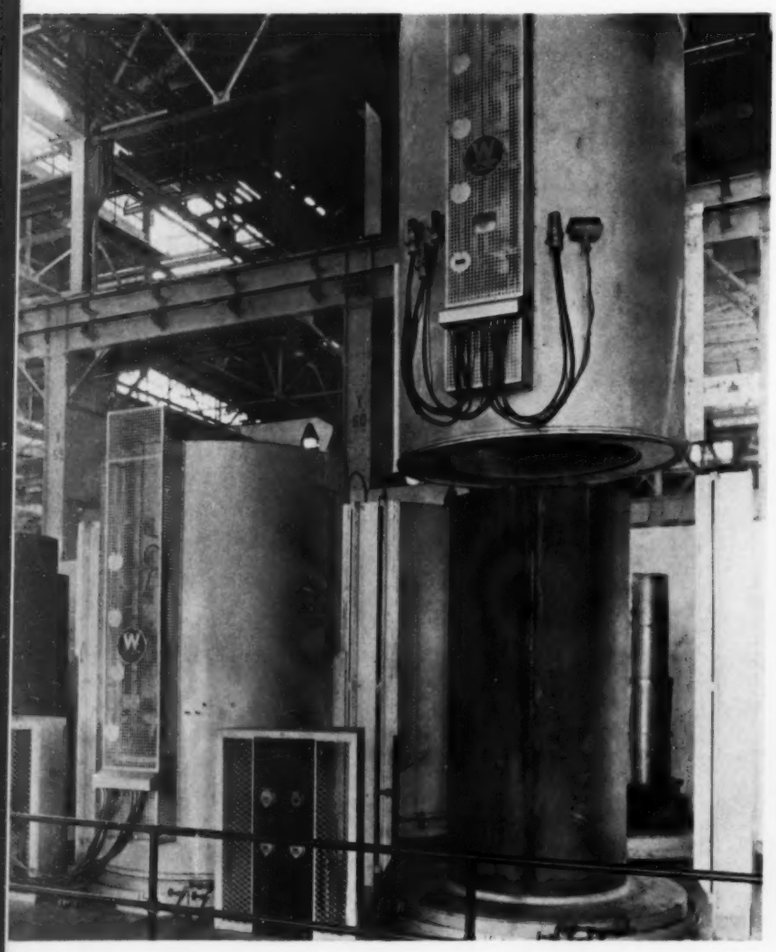
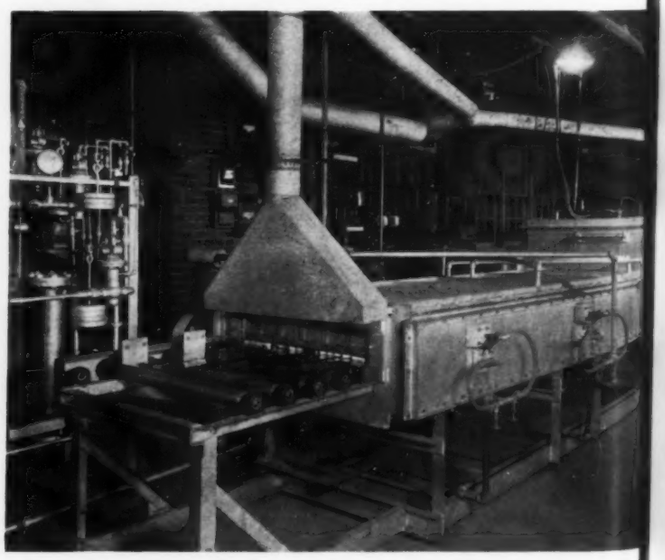


Fig. 8. Experimental electric furnace for normalizing.



tation of carbides decreases, and the character of the precipitated carbide tends to be less favorable.

The next step was to determine the change of temperature to be employed in the "shelf" zone, and the temperature range in which it was to be applied in order to obtain the highest ductility and lowest hardness. The various time limitations imposed on the remainder of the cycle left a time of about two minutes to be spent in the shelf region, so the problem was to find how best to spend the two minutes as to temperature range and rates of cooling. From an inspection of Figure 11, it can be seen how the investigation was designed in order to cover all possibilities of shelf temperatures and cooling rates.

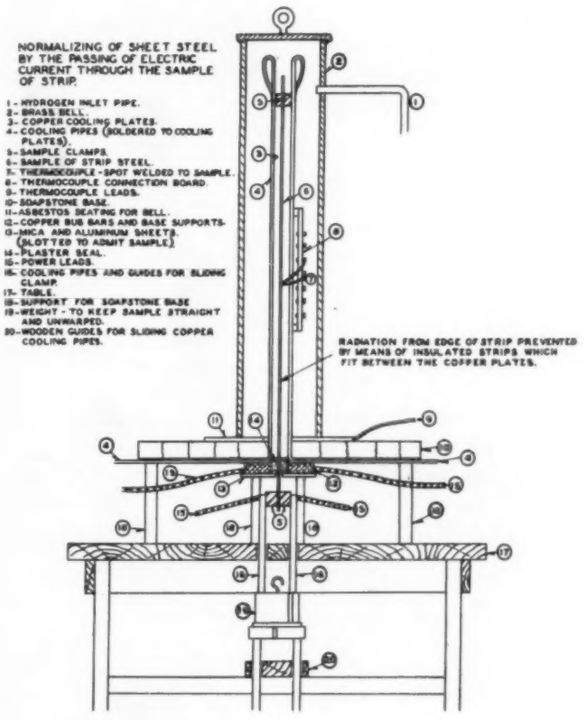

NORMALIZING OF SHEET STEEL BY THE PASSING OF ELECTRIC CURRENT THROUGH THE SAMPLE OF STRIP.
1- HYDROGEN INLET PIPE.
2- BRASS BELL.
3- COPPER COOLING PLATES.
4- COOLING PIPES (SOLDERED TO COOLING PLATES).
5- SAMPLE CLAMPS.
6- SAMPLE OF STRIP STEEL.
7- THERMOCOUPLE - SPOT WELDED TO SAMPLE.
8- THERMOCOUPLE CONNECTION BOARD.
9- THERMOCOUPLE LEADS.
10- SOAPSTONE BASE.
11- ASBESTOS SEATING FOR BELL.
12- COPPER BUS BARS AND BASE SUPPORTS.
13- MICA AND ALUMINUM SHEETS. (SLOTTED TO ADMIT SAMPLE.)
14- PLASTER SEAL.
15- POWER LEADS.
16- COOLING PIPES AND GUIDES FOR SLIDING CLAMP.
17- TABLE.
18- SUPPORT FOR SOAPSTONE BASE.
19- WEIGHT - TO KEEP SAMPLE STRAIGHT AND UNWARPED.
20- WOODEN GUIDES FOR SLIDING COPPER COOLING PIPES.
RADIATION FROM EDGE OF STRIP PREVENTED BY MEANS OF INSULATED STRIPS WHICH FIT BETWEEN THE COPPER PLATES.

Fig. 9. Research test furnace.

The results of the shelf cooling rate and temperature investigation are shown in Figure 12. The curve of Olsen values against average shelf temperatures for a shelf cooling rate of 90° F./minute lies substantially above the curves which correspond to faster and slower cooling rates, so the inference was drawn that a cooling rate of about 90° F. per minute produces, in normalized sheet, a close approach to the maximum Olsen values.

The remaining step was to take the developed cycle, now fairly well defined in every respect except the average shelf temperature to be used, and, using a 90° F./minute shelf slope, raise and lower the shelf temperatures over a range while maintaining the remainder of the cycle constant. This procedure was carried out on several different lots of steel from different sources. The curves obtained are shown in Figure 13. A composite graph was drawn; it appears in Figure 14. From the curves as plotted, it was evident

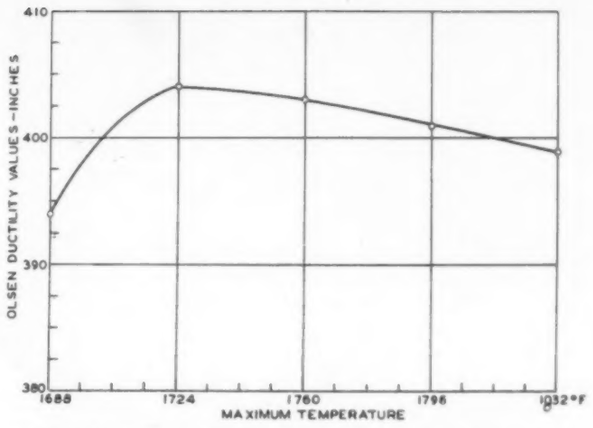


Fig. 10. Effect of top temperature.

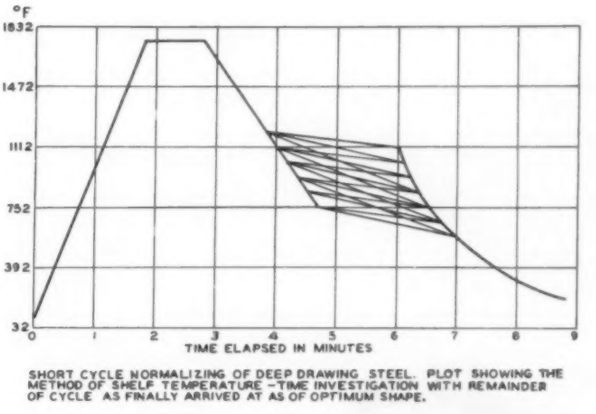


Fig. 11. Shelf conditions.

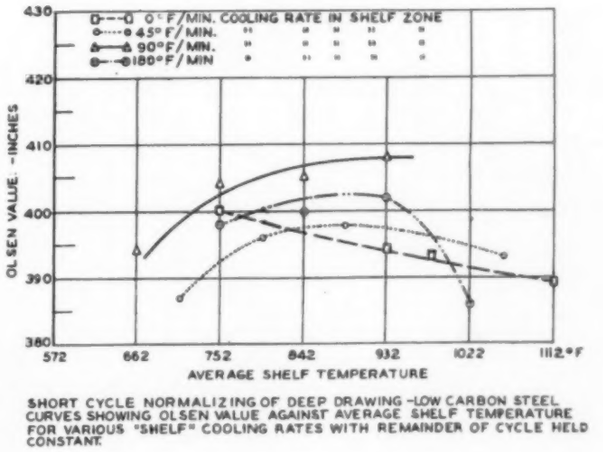
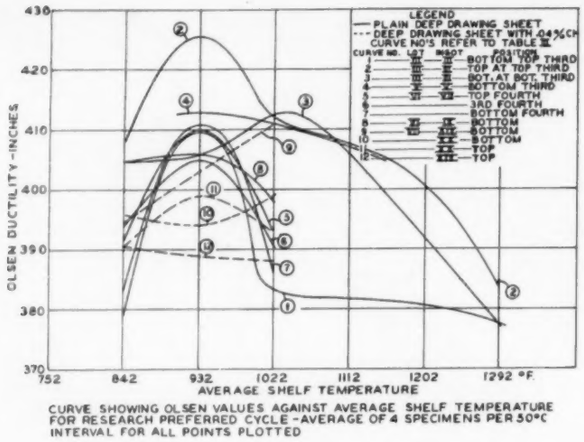
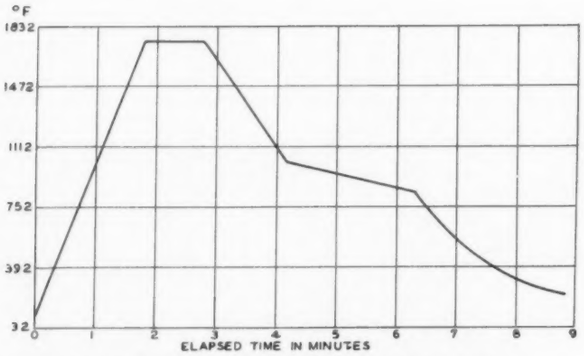


Fig. 12. Shelf cooling rates.



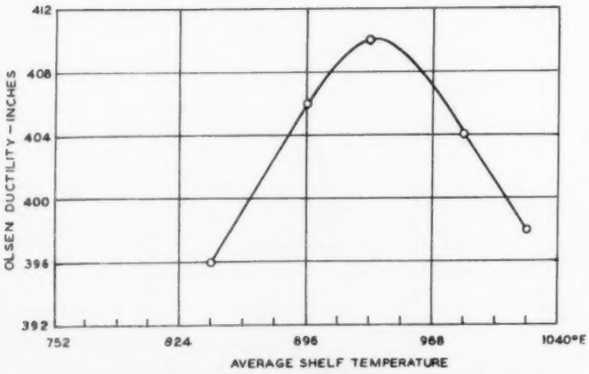
CURVE SHOWING OLSEN VALUES AGAINST AVERAGE SHELF TEMPERATURE FOR RESEARCH PREFERRED CYCLE - AVERAGE OF 4 SPECIMENS PER 50°C INTERVAL FOR ALL POINTS PLOTTED

Fig. 13. Shelf average temperatures.



SHORT CYCLE NORMALIZING OF LOW CARBON DEEP DRAWING STEEL PREFERRED CYCLE DEVELOPED AT THE RESEARCH LABORATORIES.

Fig. 14. Shelf average temperature composite.



COMPOSITE CURVE OF OLSEN VALUE AGAINST AVERAGE SHELF TEMPERATURE FOR RESEARCH PREFERRED CYCLE. INCLUDES VALUES FOR ALL NON CHROMIUM BEARING STEELS TESTED.

Fig. 15. Preferred sloping shelf cycle.

that the maximum ductility is found in most cases with an average shelf temperature of 930° F. This conclusion enabled a preferred sloping shelf cycle, Figure 15, to be drawn as combining all of the best features as found by investigation.

The curves indicate that ductility figures averaging better than 400 Olsen can be obtained by the use of the cycle developed. Seven out of eight different steels tested having low chromium content showed distinct peaks in Olsen value in a restricted range of shelf temperatures whose average was 930° F. The work seems to indicate that the *preferred* sloping shelf cycle produces as high ductility values as can be produced within the available shelf time of two minutes. The hardnesses were followed closely, and the values confirmed and the conclusions reached in the preliminary investigation that minimum hardnesses are obtained with an average shelf temperature of 930° F.

The chromium bearing steels do not respond to treatment as well as do the steels with low chromium. This is not surprising in view of the general influence of chromium on the reaction rates of plain carbon steels and on the properties of the products of reaction. An amount of .04% chromium represents an appreciable percentage of the total metalloid content of the steel.

4. *Second Cooling Chamber Conditions:* At the end of the shelf phase there exists a dilute solid solution of carbon in ferrite in which occur scattered islands of pearlite formed during the first cooling phase, together with minute particles dispersed more or less uniformly throughout the mass of the metal. Prolonged heating at progressively lower temperatures will cause further coalescence of the minute carbide particles and some further carbide precipitation, but experiments showed that the benefits thus gained were not commensurate with the time required. In fact, a quench was applied at the end of the shelf phase and found to give quite good results both as to hardness and ductility. Therefore, it was considered permissible to limit the time spent in the final cooling phase to little more than 2½ minutes.

5. Metallurgical Studies

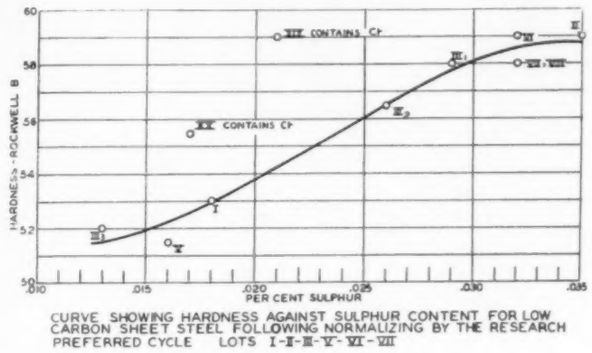
(a) Hardness

The present investigation indicated that an average sloping shelf temperature of 930° F. produced minimum hardness. Rather unexpectedly, the hardness was found not to correlate with the carbon content of the strips. The data as to hardnesses as normalized and as to sulphur content of all sheets whose chemical analyses were closely known, were assembled to give Figure 16. As far as we know, no such results have been recognized previously, and, while hardness was secondary in importance to ductility in this investigation, the results seemed to indicate the cause of an annoying scatter in hardness figures. The correlation between hardness and sulphur content was unexpected, inasmuch as sulphur is generally not considered to be a hardening element.

(b) Shelf Conditions

The general shelf condition may take the form of a re-heat shelf or the preferred sloping shelf just described. Figure 17 shows comparative results for the preferred sloping shelf cycle and for two re-heat shelf cycles

which gave the best results of any re-heat cycles tested. The hardness in all three cycles is approximately the same, but the usual experience with re-heat cycles has been that, if the length of the re-heat cycle is reduced much below twelve minutes by shortening all parts of the cycle proportionately, or by omitting the shelf feature (see A on Curve 2) lower Olsen and increased Rockwell hardness figures result. Curve 3 shows a re-heat cycle which gives nearly the same results as



CURVE SHOWING HARDNESS AGAINST SULPHUR CONTENT FOR LOW CARBON SHEET STEEL FOLLOWING NORMALIZING BY THE RESEARCH PREFERRED CYCLE LOTS I-II-III-V-VI-VII

Fig. 16. Sulphur influence on hardness.

obtained by the preferred sloping shelf cycle. This re-heat shelf cycle is about 15 minutes in length, and our work has shown no appreciably shorter re-heat cycle which produces equally good Rockwell and Olsen values in the normalized sheet.

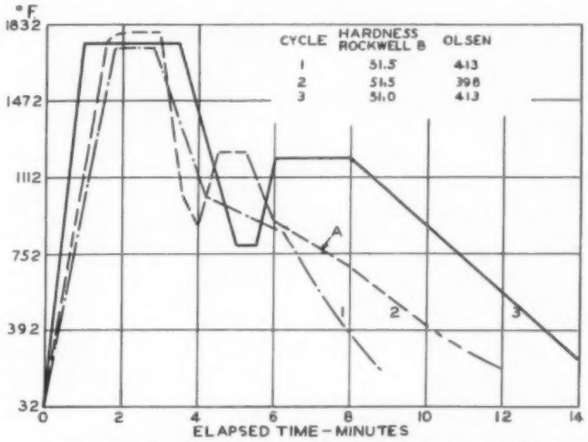
The theory of the re-heat cycle may be outlined as follows: Heating into the gamma region (see Figure 2) brings the carbon into solution and removes the hardening effects of the cold rolling. Cooling abruptly to approximately 850° F. allows insufficient time to reach equilibrium and, incidentally, minimizes grain growth. Consequently, the alpha-gamma changes occur at subnormal temperatures causing the carbides and pearlitic areas to be more finely dispersed than would be the case after a slow cool. It is probable that, at the end of the first cooling, some gamma solution is still in existence and that the alpha solution has not had opportunity to become saturated with carbon while in the entectoid region and again precipitate the excess corresponding to the final temperature. Re-heating to a temperature between approximately 1100° and 1300° F. affords opportunity for completion of the delayed constitutional changes. As a result, there exists at the end of the re-heat an alpha solution of medium grain size saturated with carbon (approximately 0.03%) and, with small pearlitic regions dispersed throughout it. Final uniform cooling at rates of approximately 100° F. per minute or less causes the carbon of the alpha solution to precipitate and form relatively massive carbide aggregations, which may distribute themselves along grain boundaries to the detriment of ductility. Relatively very prolonged cooling is necessary to allow these carbides to assume the less harmful spheroidal form.

The theory and results of the sloping shelf cycle are entirely different. The gamma solution resulting from the initial heating is cooled rapidly to approximately 1020° F., thus securing a low carbon alpha solution, containing a fine dispersion of pearlite and possibly some residual gamma solution. Retarded cooling in the shelf region allows the delayed reactions to take place, but minimizes migration of carbides to the grain boundaries. Instead, the precipitated carbide particles tend to remain disseminated throughout the mass of the alpha iron where they do little damage to ductility, although exerting some slight hardening effect. The net result of the sloping shelf cycle is to secure an alpha solution in a healthy low carbon condition and to distribute the carbon between pearlite and isolated carbide particles in such a way that it has little adverse effect on ductility.

The above considerations were, in part, confirmed by metallographic inspections of normalized samples. Obviously, it is not possible to control the disposition of all of the carbides by so short a heat treatment, but the considerations outlined indicate the trends attending the various heat treatments. The metallographic inspections of a limited number of specimens suggested that, in the steel normalized by the preferred sloping shelf cycle, the grain size tended to be slightly more uniform from center to surface than in the steel subjected to the re-heat shelf cycle.

(c) Shelf Cycle Characteristics

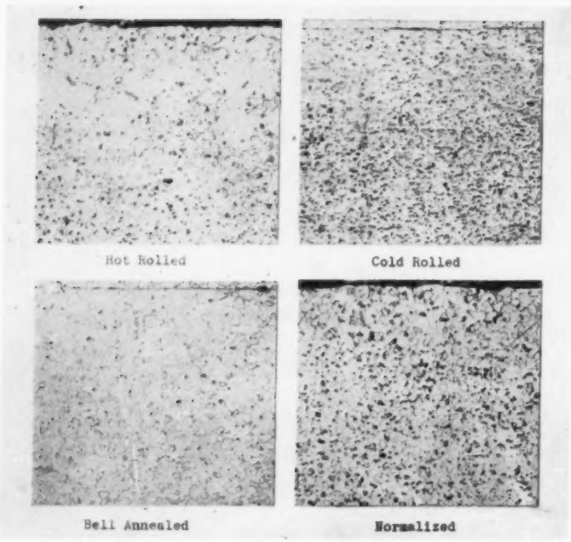
From the metallurgical standpoint, there has been developed a 9-minute cycle for the continuous normalizing of low carbon steel sheet whose distinguishing features are a quick heating to 1740° F., a fast cooling to an intermediate temperature range (1020-840° F.), a cooling at a slower controlled rate through this shelf, and, finally, a relatively rapid cooling to approximately 280° F. Olsen ductility values averaging substantially



COMPARISON OF RESEARCH PREFERRED CYCLE AND BEST REHEAT CYCLES OF 12 AND 15 MINUTE LENGTH.

Fig. 17. Re-heat cycles.

more than .400" were obtained in applying this cycle to a number of samples of steel from different ingots and from different producers. These values compare favorably with values obtained for steel after bell annealing or re-heat normalizing, and were obtained in a



Figs. 18--21
Top Left: Photo micro hot rolled.
Top Right: Photo micro cold rolled.
Bottom Left: Photo micro bell annealed.
Bottom Right: Photo micro normalized.

time of 9 minutes as compared with 2-5 days for the bell annealing and at least 15 minutes for the re-heat shelf normalizing. Rockwell hardnesses of 50 to 60 on the B scale were obtained, which values, while higher than are obtained by bell annealing, are low enough that normalized material can be substituted for bell annealed material in commercial processing, except for the deepest draws.

This cycle was found to have peculiarities. The hardness was found not to correlate with the carbon content of the steel, as is indicated in bell annealing, and was unfavorably affected by the presence of sulphur and chromium. Later work gives promise that, by modifying the cycle, it will be possible to develop, in normalized chromium bearing steel, properties as good as those developed in low chromium steels. The heat treatment response was most favorable when the cold rolled stock was normalized within two weeks after cold rolling.

(d) Grain Structure

The comparative grain structure of annealed and normalized sheet throws some light on their drawing characteristics. Figure 18 is a micro-photograph of hot rolled material. This shows a difference in grain size from the edge to the center of the material, indicating persistence of the original ingot structure. It is probable that a segregated condition of the carbon in the original ingot has persisted down to the hot rolled strip. This strip was approximately .090″ thick at this point. Figure 19 shows the same material after it had been cold reduced to approximately .040″ thick. It will be observed that the grain structure has been thoroughly broken up by the cold reduction.

Figure 20 shows the grain structure in the same material from a bell annealing cycle at 1350° F. It will be observed that some of the hot rolled structure, involving relatively coarse grains at the surface and finer grains at the center, still persists, due to differences in carbon content at the different points. Figure 21 shows the same material after the normalizing operation. The uneven grain size of the ingot structure has been almost completely eliminated, producing a material of uniform grain size from which all visible evidence of grain distortion has been eliminated.

(e) Other Characteristics

We are unable, at the present writing, entirely to evaluate our test results because a sufficiently wide experience has not yet been accumulated on the correlation of these characteristics with the performance in dies. It appears, however, that fine grained normalized steel has less tendency to "orange peel" in drawing than is the case with the present commercial grades of bell annealed steels. It also appears that normalized steel has a somewhat better characteristic than the bell annealed with reference to permissible speed of deformation on medium draws without causing failure, although it will not take as deep a draw as bell annealed steel. The normalizing treatment seems to give the steel the characteristic of being able to undergo deformation at a high rate of speed without tearing. This has advantages in that press speeds might be further increased to take advantage of the better handling conditions resulting from the use of coil stock instead of sheets.

It has also been indicated that operating advantages exist through the use of continuous normalizing furnaces in that material can be processed in a matter of a few minutes instead of many hours or days. This is a distinct advantage in matching up with other line production activities, holds investment in stock to a minimum and frequently avoids delays that might otherwise amount to 2 or 5 days' time. It has proven to be a tool which appeals to a production minded organization.

(f) Future Possibilities

The sheet normalizing furnaces built to date have been of conventional construction, the sheets being heated by radiation from wall heaters and cooled by fan circulation of an atmosphere through coolers. The cost and length of a furnace are closely controlled by the heating and cooling chambers. The Research Laboratory holds forth the promise that either or both of these present limitations may be modified, provided industry finds normalizing sufficiently attractive to warrant continued development. The steel may be brought to soaking temperature quickly by passage of current through the sheet, thereby shortening the heating chamber, reducing the amount of wall heaters and improving the economy. Similarly, there are attractive possibilities of faster cooling between the soaking temperature and the shelf temperature that will eliminate fan circulated atmosphere as a cooling medium and replace it with water cooled means. Our work has already disclosed that using a sloping shelf cycle, the final cooling chamber may be entirely replaced by a quench chamber. These and other possibilities are still in the laboratory stage of development and cannot be properly evaluated at the present time.

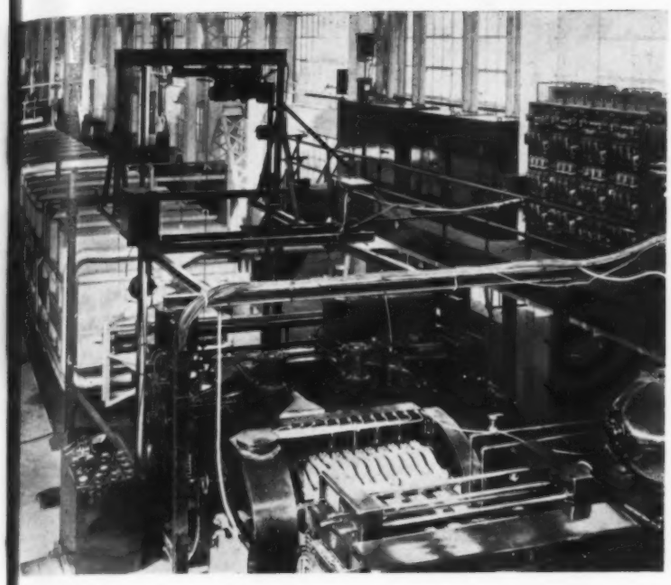


Fig. 22. 5-Ton normalizing furnace 230′ long with a connected load of 1250 KW.

6. Normalizing Furnaces

Our research findings have guided the design of a 5 ton per hour and a 7½ ton per hour continuous bright normalizing furnace to handle 19 and 20 gauge auto body stock, installed in the Ford Motor Company factory in 1935 and 1936. The 5-ton furnace, Figure 22, is 230 feet long, has a connected load of 1250 kw., and is built to handle 20 gauge sheet, 50″ wide. The second furnace, Figure 23, is 325 ft. long, has a connected load of 2335 kw., and is capable of producing 7½ tons per hour of bright normalized 20 gauge sheet, 56″ wide.

In view of the incompleteness of our research program and the pending possibilities of further development, it was decided to design this larger furnace to permit a wide variation of its time temperature cycle, particularly from the end of the initial heating period to the beginning of the final cooling period. The normal chemical variations in auto body steel indicate the desirability of a "flexible" type of furnace which will permit the operator to vary the time temperature relationship in the shelf region to accommodate variations in the steel chemistry to suit the particular application.

The furnace is provided with a conventional heating chamber 100 ft. long, a first cooling chamber 60 ft. long lined with an insulating refractory and containing three 5000 cu. ft./min. groups of external centrifugal blowers and coolers, a "flexible shelf" chamber 60 ft. long lined with a semi-insulating refractory and equipped with wall heaters to develop a sloping or re-heat shelf, as desired, and a second cooling chamber 100 ft. long equipped with 21 internal propeller type fans and coolers. The coolers in the lightly insulated first cooling section may be run over a range of speeds or shut down, as desired, permitting a wide range of cooling rates in this section. By automatic control of the wall heaters in the shelf section, a range of shelf conditions from a re-heat to the preferred sloping shelf previously described, may be obtained. The second cooling chamber has sufficient capacity to reduce the temperature of the sheet to 250 to 300° F., before delivery to the outside air.

The entire furnace is enclosed in a gas-tight steel shell continuously supplied with a controlled atmosphere. This atmosphere consists of partially combusted coke oven gas carefully purified and contains a high hydrogen content suitable for maintaining a bright, clean sheet under all operating conditions. All removable roof sections beyond the first heating section are equipped with water-cooled oil seals which effectively prevent any gas or air leakage. The entire furnace is large and liberally designed for its stated capacity and has been arranged to permit a maximum degree of flexibility of type of cycle.

Figure 24 shows a schematic arrangement of the layout which has been made for the second and larger

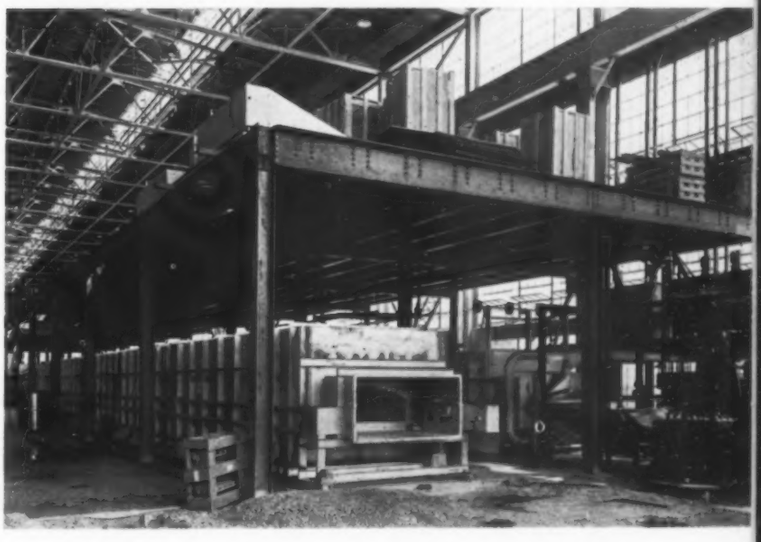


Fig. 23. 7½ ton normalizing furnace 325′ long with a connected load of 2335 KW.

unit. The material is carried to the furnace structure in coil form from the cold mills. No re-coiling or cleaning operations are required. At the furnace, the material is placed in spool type uncoilers which rigidly grip the coil and allow it to pay off smoothly. The strip passes from the uncoilers through straightening rolls and thence into a welder which is provided to join the rear end of one strip with the front end of the succeeding strip. This welder is built with a number of movable heads which spot weld the material across the sheet. The whole operation takes about 20 seconds. Pinch rolls are provided on either side of the welder,

which may be utilized to hold the strip in the proper relationship while it is being welded. Between the last pinch rolls and the furnace there is provided a looping device consisting of a roll attached to a hoist mechanism which can be lifted to provide a large loop when desired. This arrangement is provided to enable the furnace operator to stop the material for welding without interfering with the continuous movement of the sheet through the furnace. After passing through the furnace, the strip passes over a looping pit, through pinch rolls, and into a shear which is provided to cut out the welds. As before, the purpose of the looping space is to permit the furnace to run continuously while the strip is stopped momentarily for shearing.

At the discharge side of the shear, the sheet comes out over a wooden faced table, through wipers, and into a hold-back mechanism consisting of two motor operated conveyors which contact the upper and lower

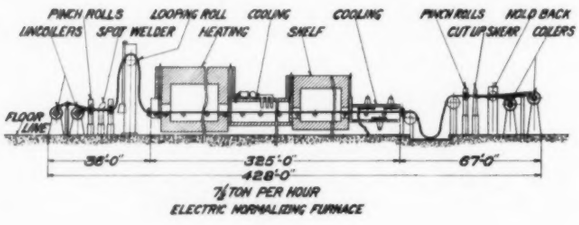


Fig. 24. Schematic layout of furnace and auxiliaries

surfaces of the strip. From the hold-back mechanism, the strip passes into either of two coilers which are arranged to be used alternately. The purpose of the hold-back mechanism is to enable the strip to be coiled under considerable tension. It has been found necessary to make use of considerable coiling tension at this point in order to prevent a tendency of the material to cross-break in being coiled. It has also been necessary to make use of comparatively large diameter reels in order to prevent cross-breaking. With these two provisions, however, the material can be turned out bright and free of scratches or cross-breaks.

7. Conclusion:

The successful development of controlled atmosphere furnaces for bright annealing and normalizing auto body sheets has been described in the foregoing. We believe the electric furnace has been developed to a distinctive place in steel mill heat-treating. Such research programs as have developed the processes described are being continued and are expected to lead to further improvements in the near future. Annealing and normalizing will ultimately find their respective indicated places in the heat-treating field and the selection will probably, in most cases, be dictated by factors other than the type of furnace itself. All of this work is looking towards the objective of producing the most suitable steel at the lowest cost, and we believe that the electric furnace is helping the steel industry to go forward in this direction.

Acknowledgment

The authors desire to acknowledge the consulting services of Mr. N. L. Mochel, Chief Metallurgist of our South Philadelphia Works; and the able assistance of Messrs. J. R. Gier and E. L. Robinson, Research Metallurgists.

CENTRALIZED LUBRICATION AND ROLL COOLING SYSTEMS

By T. J. KAUFFELD, Special Representative
DeLaval Separator Company
PITTSBURGH, PA.

Abstract of paper to be presented before the A. I. & S. E. Convention, Detroit, September 22, 23, 24, 25, 1936.

▲ WHEN TWO solid bodies are caused to slide in contact with one another, there is more or less resistance to motion which results in an absorption of energy that is manifested as heat. While some of this resistance to motion is probably due to molecular cohesion or adhesion, it is chiefly due to the interlocking of projecting portions on the uneven surfaces of the bodies. This phenomena is generally known as friction. Since it is almost physically impossible to prepare an absolutely smooth surface, it is therefore necessary to employ a lubricant—which is generally an oil—to keep the metallic surfaces apart when it is desired to lessen friction, as in metallic bearings.

Mr. A. H. Gill in Rogers and Auberts "Industrial Chemistry" says, "—the cardinal principle underlining all lubrication is to use the thinnest, or least viscous, oil that will stay in place and do the work—." However, he neglected to mention that it is equally, if not

more, important that the oil used to do the work be maintained in as close to its original condition as possible to be sure that it will continue to do the work.

A fundamental requirement of all lubrication is that the lubricant, as used, should adhere to the moving solid parts with a consequent shearing of the lubricating layer. This means then, that a good lubricant is one which offers but little resistance to shearing; or, in other words, has but little friction between its own moving particles consistent with speeds and loads The amount of this internal friction has been designated by the term viscosity and it is possessed by all oil in varying degrees.

The effect, or influence, which temperature will have on a lubrication recommendation will depend upon the extent to which the operating temperatures may vary. High temperature operation is worthy of special consideration as the viscosity of an oil will vary inversely with the temperature. In other words, the higher the temperature of operation, the greater will be the tendency for the body, or viscosity, of the lubricant to be reduced. If the original viscosity is not high enough to allow for this reduction, the increased fluidity may lead to impairment of the lubricating film to such an extent as to actually cause metal to metal contact.

It is sometimes not realized by an operator that, although a lubricant may have had the proper viscosity when new and placed in service, it will not retain this viscosity unless it is properly maintained as to cleanliness and limiting of temperature. This is due to the gradual accumulation of foreign products in the oil, such as moisture, sludge, and solid particles some of which may be of an abrasive nature. We all know that water, with its extremely low viscosity, impairs the oil film. Sludge, which sometimes has viscosities approaching those of greases, increases the resistance of the oil film to shearing. Gradually a point is reached when the percentage of contamination is so great that friction increases, causing an abnormal increase in temperature with a consequent abnormal loss in viscosity of the lubricant. The result is a thinning of the oil film causing excessive wear due to partial metallic contact of the bearing parts. Proper maintenance consists of continuously keeping the oil free of this harmful contamination.

While the use of an oil of sufficient viscosity to meet the operating conditions will, of course, result in more effective lubrication, when properly maintained it will also result in a decided factor in reducing the amount of power or energy required to move the working elements. In addition, any tendency towards the development of abnormal frictional heat will be reduced. All this leads to improved lubrication for it will enable the oil to perform its function more perfectly, maintaining the proper lubricating film under all conditions, by virtue of its viscosity or body.

In cases of low temperature operation, there is less possibility of metal to metal contact but greater danger due to contamination of the oil. Under such conditions, we must be more concerned with the possibility of developing abnormal internal friction within the body of the lubricant itself. This would, of course, lead to increased power consumption. In brief then a lubricating oil should have sufficient adhesion and viscosity to enable it to stay in place when properly maintained but if it possesses greater viscosity than this, power is wasted in shearing the oil. If the viscosity is less than that required, metal to metal contact takes place eventually.

Another fundamental fact to be considered in choosing oils to be used as lubricants is that they be as chemically inert as possible. Lubricating oils belong to two major classes namely; the fatty oils which are both animal and vegetable in origin and the mineral oils. The former are relatively active and the latter inert.

Fatty oils in general are more or less affected by exposure to the atmosphere. Some of them are quite susceptible to oxidation and are converted into a dry hardened mass. These are the paint oils, and this property which makes them suitable for paints manifestly renders them useless for lubrication. Others of these fatty oils that do not oxidize sufficiently to form a hardened mass become thickened to such an extent that friction would be greatly increased by their use. To some extent, the fatty oils react with moisture in the air, the reaction which they undergo being known as hydrolysis. However, the hydrolysis that occurs upon exposure to the air is small in amount compared to that which occurs in steam cylinders when and where fatty oils are used. In other words, a decomposition of the fatty oil takes place resulting in the formation of a fatty acid and glycerine. The fatty acids thus developed attack the metallic bearings particularly when the metal is alternately exposed to the acidified oil and then to the air.

The mineral oils on the other hand, are relatively quite indifferent to the action of the atmosphere under normal conditions.

As has been shown, lubricants may consist of either fatty or mineral oils. Mineral oils are most used, for aside from their chemical stability they are the cheapest of all the oils. Still, for certain purposes they are improved by an admixture of certain vegetable and animal oils. For example, in steam cylinder lubrication an admixture of a fatty oil helps to cause the oil to adhere to the metal. These mixtures are called compounded oils. Fatty oils are only to a comparatively small extent used alone. For especially heavy burdens, the oils are thickened to form a grease by means of soaps or lime and these may be further reinforced with mica, graphite or the talcose variety of soapstone. For convenience in discussing, then, lubricants may be separated into the following classes; mineral oils, fatty oils, and greases, and we will confine ourselves to the treatment and maintenance of mineral oils in centralized pressure lubrication systems.

An oil may be identified by a careful determination of its iodine number, saponification value, specific gravity and other properties but the determination of the nature of mixtures of fatty oils is complex and difficult. Aside from tests for identification, lubricating oils are usually examined for specific gravity, viscosity, flash point and fire test, volatility and acidity.

The characteristics possessed by straight mineral oils when first placed in service are inherent properties of that oil and *cannot* be changed by purely mechanical means. In other words, oil in service does not wear out but becomes unfit for use through mechanical

contamination with dirt, metallic particles, carbon, water, and the result of certain slow chemical reaction. Therefore, if this contamination is removed by mechanical means, we should expect to have the remaining oil practically in its original condition—which is exactly what takes place.

Lubricants employed in steel mills are probably subjected to greater abuse and by far more contamination than in any other service. Up to a comparatively few years ago much lubrication work was carried on by rule of thumb. It is just recently that lubrication of steel mill equipment is receiving the proper scientific attention which it deserves, and this work is being promoted by the Lubrication Section of the Association of Iron and Steel Engineers. Since attention has been turned to the care in selection and proper maintenance of steel mill lubricants, many companies have experienced considerable savings in longer life of equipment. This is due, of course, to better lubrication resulting in reduced maintenance. At the same time, the scientific application and maintenance of the lubricant usually results in a drastic reduction of the total mill cost for lubrication.

While some of the older mills are still using sight lubricating devices, continuous centralization pressure circulating lubrication systems of large capacity are the rule in the modern plant. Due to the nature of the work, the usual contamination of the lubricant is due to scale, dust, metallic particles, carbon, water and other impurities, much of which was originally suspended in the atmosphere. The problem of maintenance presented, is to remove the contamination at a rate in excess of that at which it can be accumulated in the oil.

The design of the modern centralized pressure lubrication and maintenance system is a highly technical subject involving an intimate knowledge of hydraulics, thermo-dynamics and the practical problems arising daily in the operation of a mill. As most every steel mill Lubrication Engineer can bear witness to, each mill has very decided operating characteristics which must be taken into consideration at the time the pressure lubrication and maintenance system is designed and it therefore becomes impossible to sell this type of equipment over the counter. Each installation must be separately engineered so that it will be sure to accomplish the purpose for which it was originally installed and if this is not done, operating difficulties are surely to be encountered at a later date.

With special reference to the modern cold strip mill rolling at high speed with heavy drafts, lubrication of the driving mechanism is not the only problem encountered. An equally important problem is that of maintaining the contour of the roll.

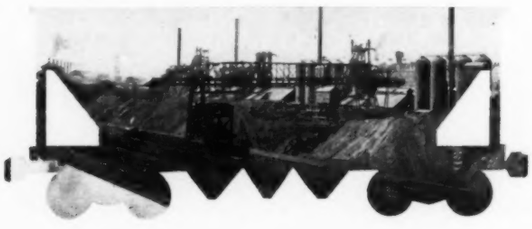
This problem is becoming increasingly acute as larger mills are being built making possible greater reductions per pass of the material being rolled at high speed. In former days, when the drafts per pass were not as great and the speeds were considerably less, it was sufficient to merely apply oil either to the strip or the roll, the idea being to maintain a film of oil between the strip and the roll to reduce skin friction. Under such conditions of operation, this practice proved sufficiently satisfactory, but it depended entirely for its temperature balance by radiation of generated heat to the atmosphere and by the increase in temperature of the material being rolled. As has been brought out by previous speakers at previous meetings, the speeds of the mills under such conditions could only be such as would maintain the heat balance.

It is obvious then, that such methods could apply primarily to what are known as jobbing mills where slower speeds could be maintained when heavy reductions were necessary and vice versa; i.e., higher speeds could be obtained if light reductions were taken.

In the modern high speed cold strip mill of today working on a production basis and taking heavy drafts, it is vitally important that a properly designed and yet economical method of positively removing the generated heat be employed. Only in this way can the heat, generated by the work performed on the material being rolled, be removed evenly from the strip and the roll surface available and so offset the great tendency towards unevenness of gauge of the strip, the spalling of hardened steel rolls, and finally the actual breakage of rolls resulting from extremely high temperature fluctuations at a great number of intervals per minute.

A properly designed roll cooling system is one which can be so adjusted as to preserve the roll contour and yet apply the cooling and lubricating medium so that it will do its work most effectively and as economically as possible. This entails not only a proper selection of the type of cooling and lubricating medium to be employed but also the careful selection of the type of system for the proper application, maintenance, or possible reclamation of this medium.

In the last analysis, the operating efficiency of any modern mill is just as dependent on the lubrication system and on the roll cooling system, if one is required, as the strength of a chain is dependent upon the character of any individual link.



Items of Interest

George E. Rose, heretofore general superintendent of the Wisconsin Steel Works, South Chicago, Ill., has been transferred to the general office at Chicago as assistant to the vice president in charge of mines and steel operations.

GEORGE E. ROSE

L. B. Robertson, formerly assistant general superintendent of the Wisconsin Steel Works, has been appointed general superintendent, succeeding Mr. Rose. W. E. Brewster, recently superintendent of blast furnaces at the Steel Works, has been appointed assistant general superintendent, succeeding Mr. Robertson.

▲

C. R. Ellicott has been appointed general manager of the Cambria plant, Bethlehem Steel Co., Johnstown, Pa., succeeding the late L. R. Custer. Starting as a chemist in the laboratory of the Bethlehem, Pa., plant upon graduation from Lafayette College in 1908, Mr. Ellicott was later transferred to No. 1 open hearth, and in 1913 was appointed superintendent. In 1915 he was made superintendent of No. 1 and 3 open hearths. From 1917 to 1922 he was superintendent of the hot metal division, comprising blast furnaces, open hearths 1 and 2, tool steel and merchant bar mills. In 1922 he was appointed superintendent of furnaces and alloy mills of the Lehigh division of the Bethlehem Company.

C. R. ELLICOTT

▲

R. E. Hough has been appointed assistant general manager. He was formerly superintendent of the Gautier mills, going to the Cambria plant in 1929 after 22 years' service at the Lackawanna plant.

R. E. HOUGH

▲

Stephen M. Jenks, as announced by The Carnegie-Illinois Steel Corporation has been appointed chief engineer of the newly established construction engineering division with offices at Pittsburgh, effective September 1.

Mr. Jenks graduated from Cornell University in 1923 with the degree of mechanical engineer, and started his business career with the Jones & Laughlin Steel Corporation at their Aliquippa Works.

His services with the United States Steel Corporation began in 1925 in the Engineering Department of the American Sheet & Tin Plate Company in Pittsburgh. In 1929, he was transferred to the Gary Sheet & Tin Plate Company in Pittsburgh. In 1929, he was transferred to the Gary Sheet and Tin Plate Mills as Fuel Engineer; returned to Pittsburgh in 1933 as power engineer of the same Company, and was promoted to assistant chief engineer in 1935, to date.

James K. Sutherland, veteran employee of The Youngstown Sheet & Tube Co., has been named assistant general superintendent of the Youngstown district, in charge of that company's Brier Hill Works.

Mr. Sutherland entered the steel business in 1905 as a lamp repairman in the electrical department of the old Valley Mill of Republic Iron & Steel Co. In 1916 he was employed by The Youngstown Sheet & Tube Co. as pit craneman in the blooming mill of its East Youngstown Works. In 1919 he went with the

JAMES K. SUTHERLAND

Brier Hill Steel Co., where he was employed as heater in the blooming mills. Later he became successively roller and turn forman. In 1924, shortly after The Youngstown Sheet & Tube Co. acquired the Brier Hill Steel Co., Mr. Sutherland was made superintendent of the blooming mill at Brier Hill plant and three years later he was transferred to the Campbell Works as superintendent of the blooming and billet mills there. In 1929 he was also given charge of the skelp mill and upon completion of the continuous hot strip mill, late in 1935, he was made superintendent thereof in addition to his other duties.

▲

Elias S. Cornell has been appointed Chief Engineer of the Delta-Star Electric Company, Chicago after serving as assistant chief engineer since 1930.

ELIAS S. CORNELL

He received his degree of electrical engineer from the University of Zurich, Switzerland and before joining Delta-Star in 1926, was engaged in power plant design and construction with American Utilities.

▲

J. J. Bangert, district representative for the Crouse-Hinds Company, Pittsburgh, is one of our many associate members who has worked diligently to promote the very high standing our association now enjoys.

Twenty years ago when the late W. T. Snyder was elected president and the late John F. Kelly secretary,

J. J. BANGERT

Mr. Bangert was associated with these men at the National Tube Company in McKeesport. Through the joint efforts of these three men, the association first began to make itself felt as an influence in the steel industry. Now upon the occasion of the Association preparing to convene at its largest session in the history of the society, it is only fitting that such men as Mr. Bangert and other associate members be recognized for the fine work they have done for the group.

▲

R. W. Davis, electrical engineer, Allis-Chalmers Mfg. Company, has recently been appointed assistant manager of their electrical department at Milwaukee, Wisconsin. He graduated in 1906 from the University of South Dakota in science and mathematics, and then specialized in electrical engineering at Massachusetts Institute of Technology, where he graduated in 1908. He entered the employment of Allis-Chalmers as a graduate student apprentice, both at the Bullock and the West Allis Works, and in 1910 was moved to the Electrical Engineering Department. From 1915 until the present time he has been actively engaged as sales engineer for the electrical department with particular reference to rolling mill applications.

Mr. Davis is a member of the Association of Iron and Steel Engineers before which organization he has, from time to time, presented papers.

▲

A. A. Van Pelt, Pittsburgh Representative, Norma-Hoffmann Bearing Corp., through an oversight was omitted from the list appearing in the August issue as being a member of the Special Committee on Bearings. Mr. Van Pelt has always been a loyal and active worker for the Association and we hasten to apologize for this omission.

APPLETON ELECTRIC PRODUCTS SERVE INDUSTRY

Type "C"—Threaded Rect. Unilet

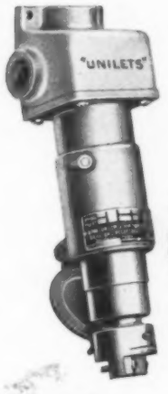
Type "C"—Threaded Form 35 Unilet

Type "LL"—No-Thread Rect. Unilet

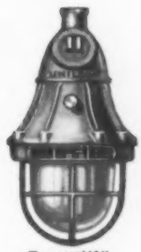
Type "LB"—No-Thread Form 35 Unilet

APPLETON UNILETS

are widely recognized as the standard fittings for all wiring jobs where durability, efficiency and ease of installation are required. Sturdy construction of malleable iron plus many other advantages make Appleton Unilets the leaders in the field.



Type "CEST" Explosion-Proof Receptacle Equipment Complete with Type "CPH" Plug



Type "EVA" Explosion-Proof Lighting Fixture (100 and 200-watt)

Type "CPSIC" Unilet Complete with Lift Cover (closed)

MDS Series Explosion-Proof Unilets

Type "EFSC" Motor Control Push Button Station

APPLETON EXPLOSION-PROOF UNILETS

remove the hazard of electrical detonation of gas or dust. Approved by Underwriters' Laboratories.

PORTAGE

Reelite

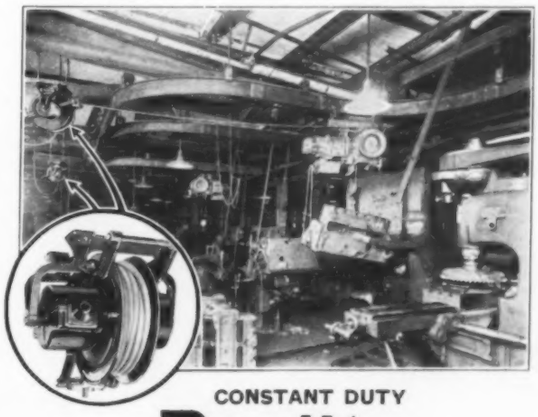
REG. U. S. PAT. OFFICE

The Handy Light on a Reel

Appleton Portable Reelites bring the light to all kinds of close work and greatly improve plant efficiency. The reel eliminates wear and tear on the cord by constantly rewinding it out of the way.

WRITE FOR INFORMATION ON APPLETON ELECTRIC PRODUCTS

Sold Through Wholesalers



CONSTANT DUTY

Reelite

REG. U. S. PAT. OFFICE

Carries current where needed

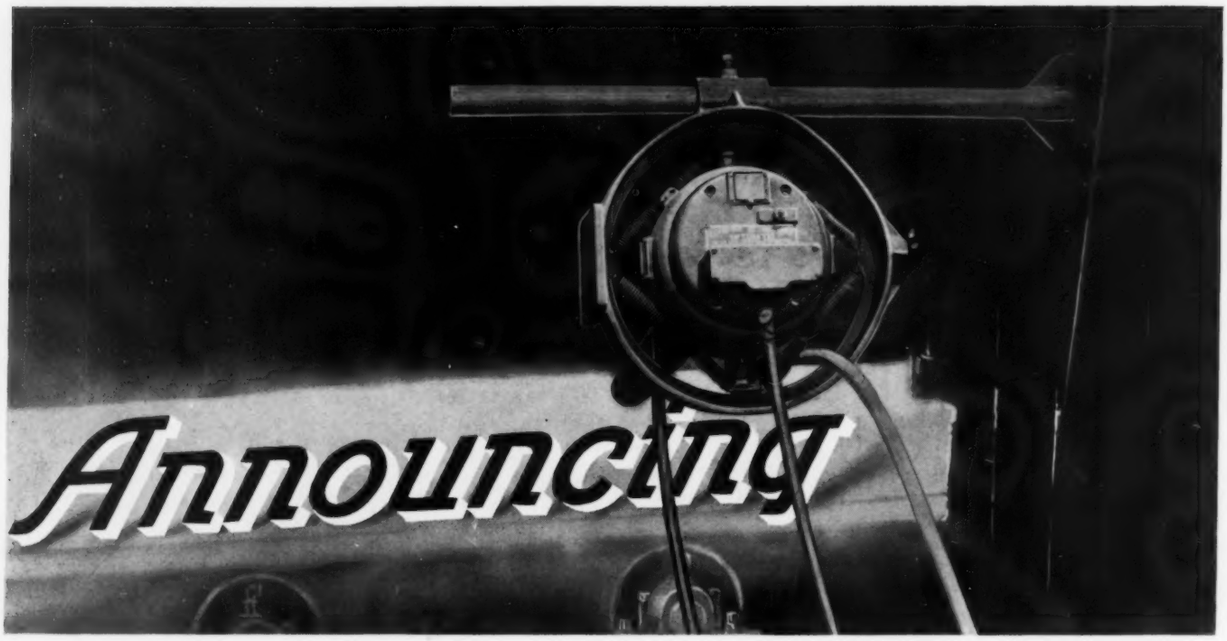
Appleton Constant Duty Reelites are in use in many important plants throughout the country in tending all types of electric cables.

APPLETON ELECTRIC COMPANY

1712 WELLINGTON AVENUE

CHICAGO, U. S. A.

NEW YORK—76 Ninth Avenue
SAN FRANCISCO—655 Minna St.
LOS ANGELES—340 Azusa Street
DETROIT—7621 Woodward Avenue
ST. LOUIS—420 Frisco Building
ATLANTA—541 Whitehall St., S. W.



THE BROWN OPTIMATIC SYSTEM

The Only Self-balancing Automatic

OPTICAL PYROMETER

The Brown Optimatic System offers to the Steel Industry for the first time, a means of recording optical temperature readings with the speed of light. Automatic in action—the human eye is eliminated.

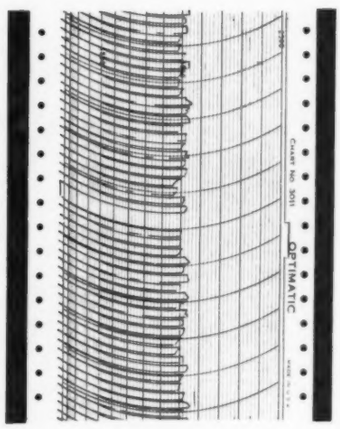
It is indispensible for measuring and recording hot moving materials in strip, plate, wire, rail, slab, sheet and rod mills, where temperature affects quality production, roll life and die wear.

The operation of the Brown Optimatic System is based on the fact that the intensity of light given off by a hot moving body is dependent upon the temperature of the object coupled to a later known basic fact, that the electrical resistance of a photo-cell varies with the intensity of the light to which it is exposed.

In application, the Brown Optimatic unit is "aimed" at the hot target. The intensity of the light emitted causes an electrical change in the optimatic circuit which is amplified and measured in degrees of temperature and recorded on a continuous strip chart.

Designed for plant service, its accuracy is unaffected by voltage fluctuations, dust, heat, moisture or vibration. Operates on A. C. current. The recorder can be mounted at any remote location from the point of measurement.

For complete details, write for Bulletin No. 91-1. THE BROWN INSTRUMENT COMPANY, *a division of Minneapolis-Honeywell Regulator Co.*, 4464 Wayne Ave., Philadelphia, Pa. Canadian factory: 117 Peter St., Toronto. European address: N. V. N. Minneapolis-Honeywell Co.. Wydesteeg 4. Amsterdam-C, Holland.



Typical chart record of a Brown Optimatic System installed in a roughing mill.

See the Optimatic in operation at The Iron and Steel Exposition, Booths No. 77-78.

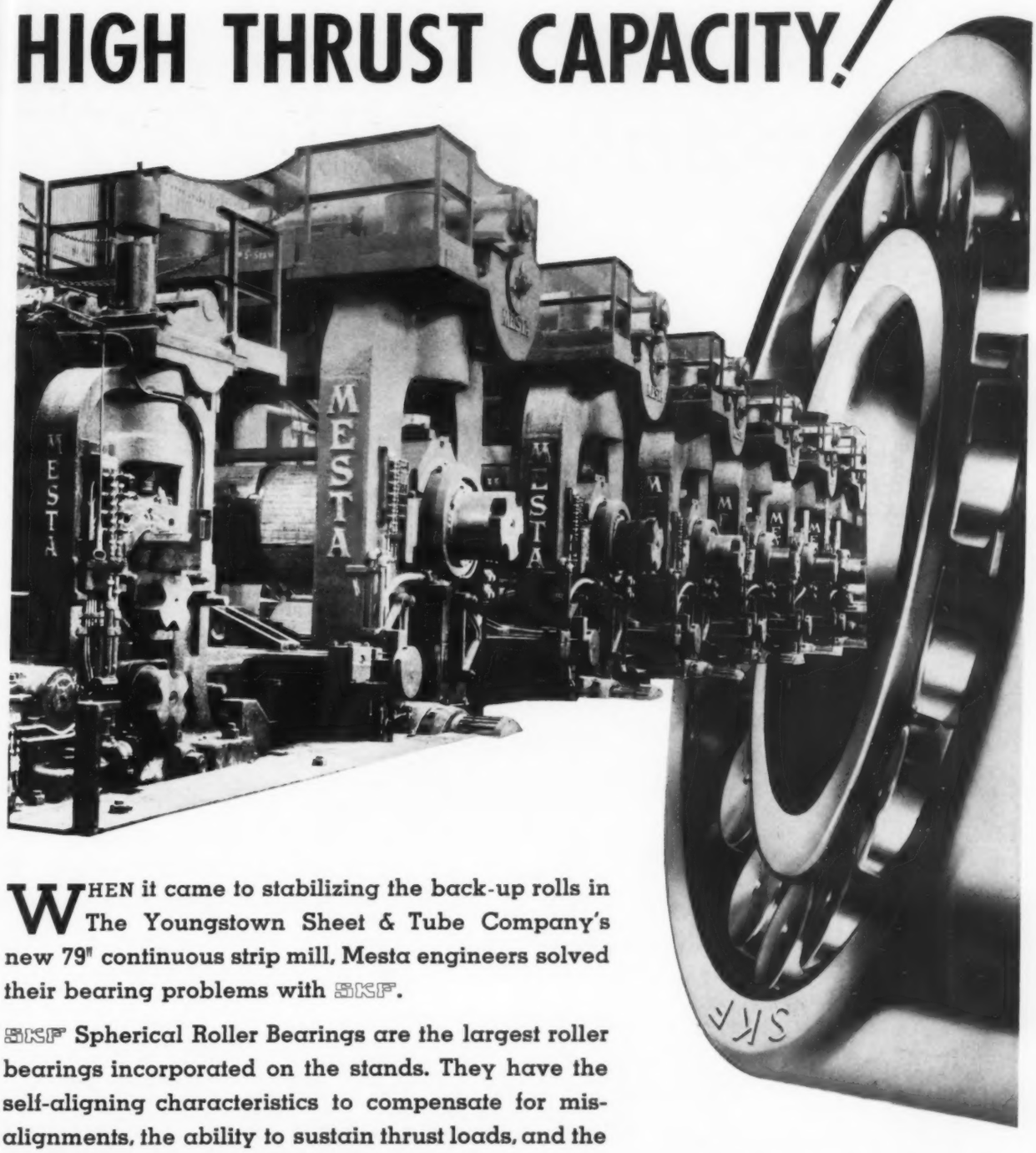
BROWN OPTIMATIC

THE ONLY SELF-BALANCING AUTOMATIC OPTICAL PYROMETER

To Measure and Control is to Economize

SELF-ALIGNING • SELF-CONTAINED

HIGH THRUST CAPACITY!



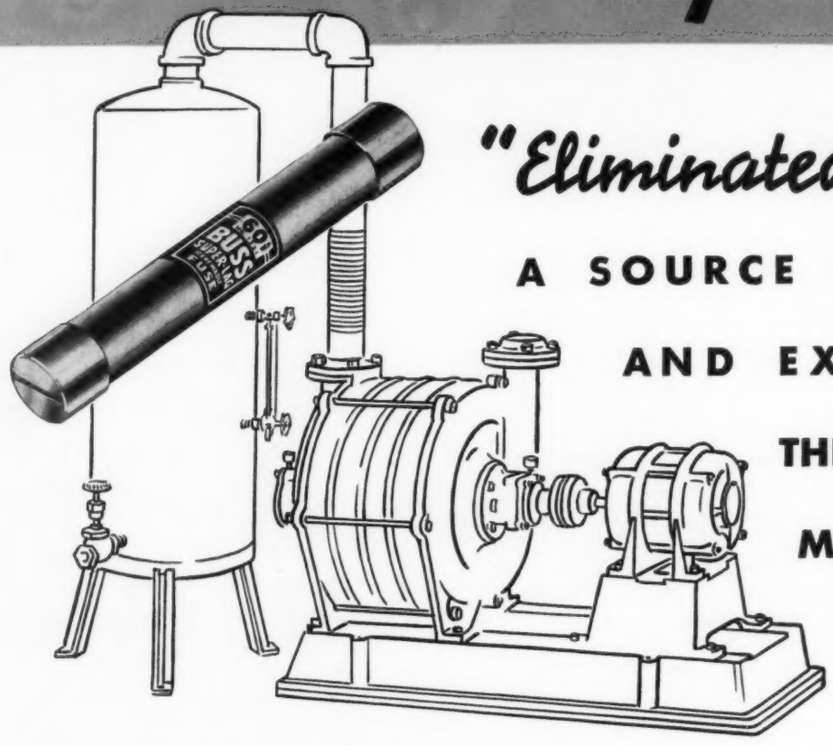
WHEN it came to stabilizing the back-up rolls in The Youngstown Sheet & Tube Company's new 79" continuous strip mill, Mesta engineers solved their bearing problems with SKF.

SKF Spherical Roller Bearings are the largest roller bearings incorporated on the stands. They have the self-aligning characteristics to compensate for misalignments, the ability to sustain thrust loads, and the stamina to assure dependability throughout a long life. Write for our new steel mill bulletin, "SKF Rolling Mill Data for Calculation and Design."

SKF INDUSTRIES, INC., FRONT ST. & ERIE AVE., PHILA., PA. 3707

SKF
ROLLER BEARINGS

fuses
MADE TO *protect*



"Eliminated...

A SOURCE OF TROUBLE AND EXPENSE FOR THE U. S. HOFFMAN MACHY. CORP."

—SO SAYS Mr. Smith of the Smith-Lipman Electric Co. Baltimore, Md. "They called us in because the 5 hp motors on their vacuum pumps were blowing 30 ampere 250 volt fuses whenever the operators were careless about gradually bringing the compensator up to full current.

By discarding the old fuses and installing Buss Super-Lag fuses we found that we could entirely eliminate the trouble. The long time-lag of Buss fuses kept them from blowing on the starting current."

. . . NOT TO BLOW!

YOU TOO, *can prevent the* RECURRING SHUTDOWNS *caused by* NEEDLESS BLOWS

The long time-lag that Mr. Smith refers to is just one of the features that makes it possible to build "Fuses made to protect—not to blow." The important point is that another executive interested in plant operation has found a practical way to eliminate the senseless shutdowns so often permitted by ordinary protective devices. He found that it paid to investigate . . .

WHY BUSS FUSES DON'T BLOW NEEDLESSLY

10 Features and *The* **Super-Lag**

in the design of the FUSE-CASE help make it possible . . . .

development in the FUSE LINK completes the job.

GET THE FACTS

You will find this new book on fuses of refreshing interest.

It sets up in concise, fast reading style, the facts about fuses and their relation to the cost of plant operation.

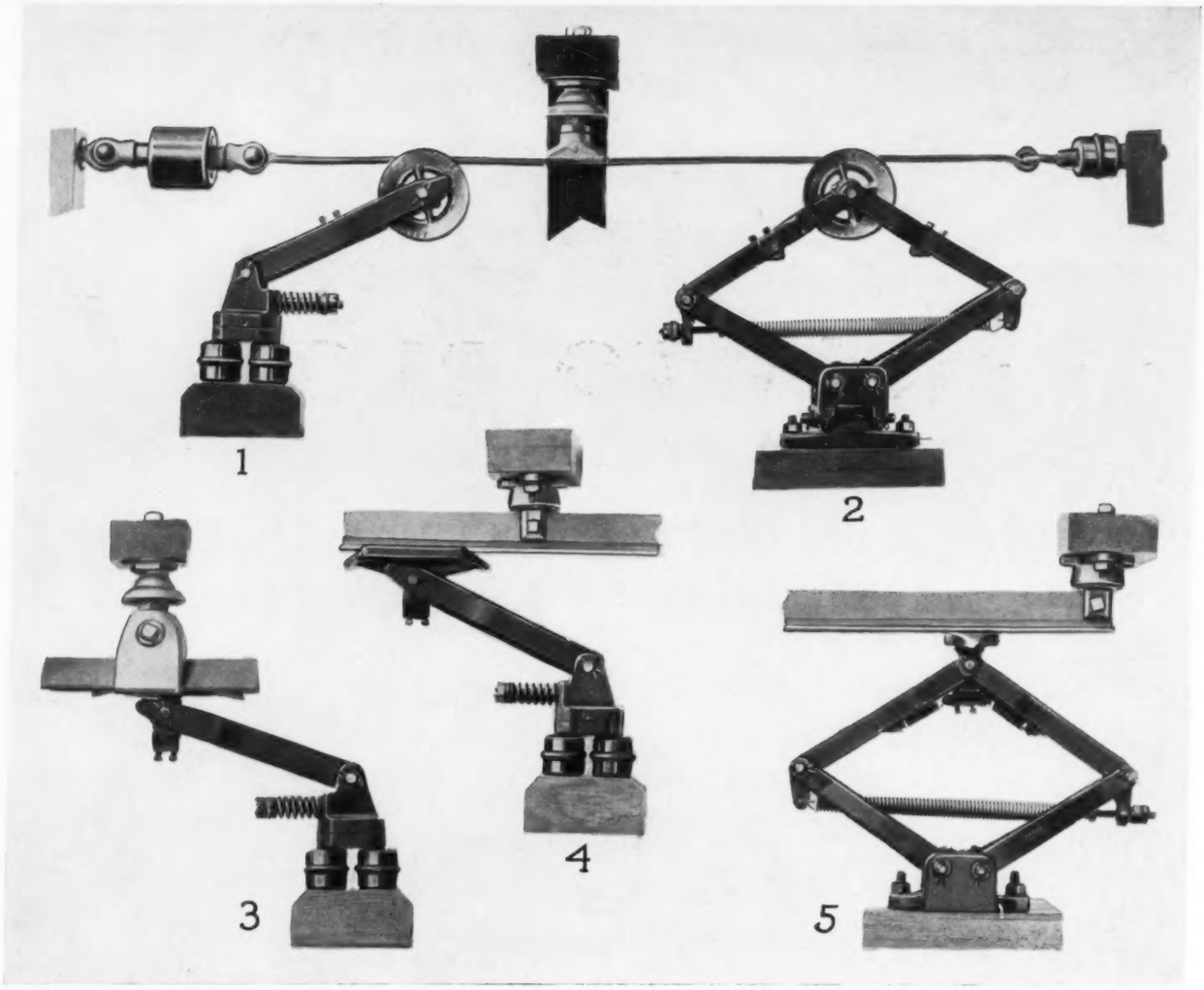
It will give you authoritative information that will be valuable to you in any discussion of fuses or any feature of the problem of electrical protection.

Your name and address will bring you a free copy. Just ask for the Rb book on "Fuses made to protect—not to blow."

BUSSMANN MFG. CO.
University at Jefferson
St. Louis, Mo.

Division of McGraw Electric Co.

BUSS super-lag FUSES



(1) Type I Universal Collector with new porcelain covered Giant strain insulator at end of wire span and center support of Type C Clamp and Type F wire suspension.

(2) Type SW Pantagraph Collector with Type U Giant strain insulator at end of wire span.

(3) Inverted V Shoe type collector for inverted angle iron suspended by No. 46341 clamp and Type F wire suspension.

(4) Flanged shoe Type Universal Collector with angle suspended by Type T suspension fitted with clevis.

(5) Type SH Pantagraph Collector with angle suspended by Type T suspension fitted with clevis.

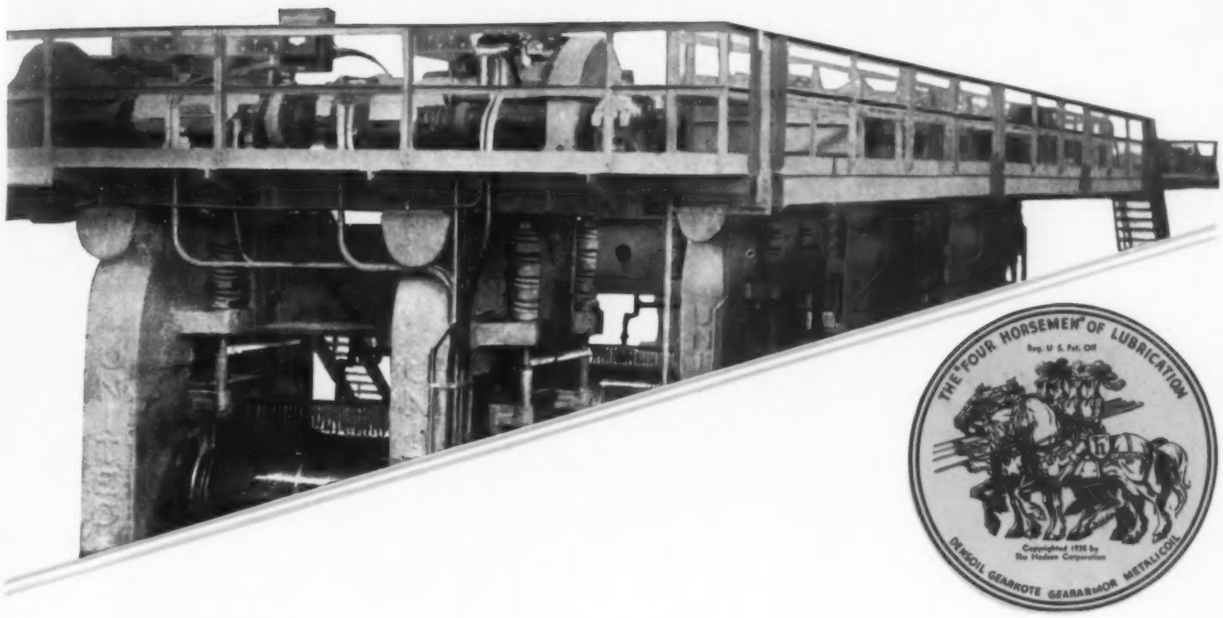
WE cordially invite you to visit us in Space No. 131, at the Iron and Steel Exposition, Detroit, where we will exhibit the Keystone Universal Collectors shown above and many of the products comprising our broad line of Keystone Electrical Equipment.

ELECTRIC SERVICE SUPPLIES CO.

MANUFACTURERS

17th and Cambria Sts., PHILADELPHIA
111 N. Canal St., CHICAGO
50 Church St., NEW YORK

Investment Bldg., Pittsburgh
General Motors Bldg., Detroit
88 Broad St., Boston



MOST STEEL MILLS FIND HODSON LUBRICATION THE BEST FOR HOT AND COLD STRIP MILL SCREWDOWNS

SCREW AND NUT GEARS AND BEARINGS

It prevents spalling and galling of the heaviest loaded worm gears and provides greater protection and more efficient lubrication for the entire screwdown mechanism in every way. Both Densoil and Metalicoil are used.

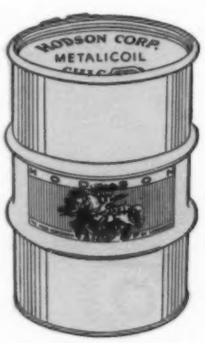
Many mills use Hodson Lubrication profitably for Pinions, Reduction Gears, Worm Drives of all types, Table Gears, Chain Drives, etc. It prolongs the life of expensive equipment and reduces operating costs to an extent unobtainable with other lubricants.

Hodson Lubrication! Now!! Why Do You Wait?
It's Costing You Money!!!

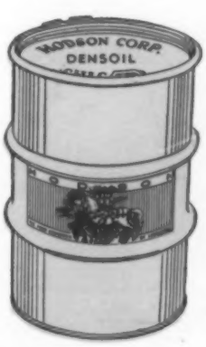
THE NEW ADAMS-SCHUETTE LUBRICATING SYSTEM

DESIGNED ESPECIALLY FOR ROLLING MILL
NECKS AND ALL OTHER HEAVY DUTY BEARINGS

- Delivers any consistency of grease, from the lightest to the highest melting Hodson Hot Neck, direct to each lubricating point, without breaking it down.
- In any amount required, at the period or periods best suited to each group of machinery, or each bearing if desired.
- One or more different kinds of greases may be used in the same system, without duplicating equipment, thus making it practical to use the right grease always.



● Our "Iron and Steel Ass'n" Exhibit at Detroit in September Will Include New Developments of Unusual Industrial Lubricants



THE HODSON CORPORATION

Lubrication Engineers and Manufacturers

5301-11 WEST 66th STREET • PHONE HEMLOCK 2676

CHICAGO, ILLINOIS

Branch Office: American Bank Building, Grant St., Pittsburgh, Pa.

IRON *and* STEEL ENGINEERS

Congratulations

ON YOUR *32*ND CONVENTION . . *and*

Welcome to TRUMBULL'S BOOTHS 20-21

TRUMBULL

TYPE "A" HEAVY DUTY
INDUSTRIAL SWITCHES

with

NEW "U" SHAPED
INSULATING CROSS BAR

Our Type "A" Heavy Duty switches particularly adaptable to the requirements of the Iron and Steel Industry, are now equipped with a new insulating cross bar—"U" shaped to prevent arc over from accumulation of conducting dust on yoke, and safeguard against grounding of switch parts in case of excessive overload.

Be sure and see our exhibit in booths 20 and 21, where we believe you will find many items of interest to you.

The TRUMBULL ELECTRIC MFG. CO.

PLAINVILLE — A GENERAL ELECTRIC ORGANIZATION — CONNECTICUT

NEW YORK • CHICAGO • BOSTON • DETROIT • ATLANTA • PHILADELPHIA • LUDLOW, KY. • SAN FRANCISCO, CALIF. • LOS ANGELES, CALIF. • SEATTLE, WA

See the exhibit of Pyle-National heavy duty electrical equipment . . . designed and built for the exacting needs of steel mill service . . .

PYLE-NATIONAL

The Pyle-National Company, General Offices and Works, 1334-58 North Kostner Avenue, Chicago, Illinois • *Offices:* New York, Baltimore, Pittsburgh, St. Louis, St. Paul, San Francisco

CONDUIT FITTINGS • LOCOMOTIVE ELECTRICAL EQUIPMENT • FLOODLIGHT PROJECTORS

NOTE

Martindale Masks are not designed to handle heavy concentrations of toxic dusts or vapors. Efficiency ranges from 85% on fine silica dust to 97% on coarser dusts.

SAFETY ENGINEERS!

Here Is a 1-2 Oz. Mask

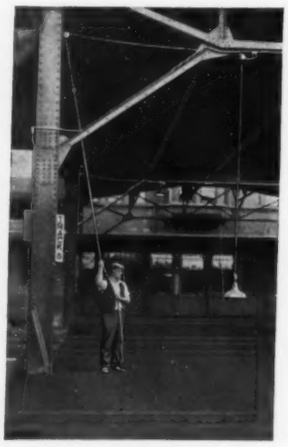
That Your Men Will Wear

Why put up with the constant battle of getting your men to wear heavy uncomfortable masks? The Martindale ½ ounce mask is the most **comfortable** mask available to industry. It is low in price and high in efficiency. Daily refills of the special cotton filter cost only a few dollars per year per worker. If you are not already among the large number of firms standardizing on Martindale Masks write today for a sample; give it to the most reluctant mask-wearer in your mill and **let him be the judge.**

Visit the Martindale Display at Booth 94,
National Safety Congress, Atlantic City.

MARTINDALE ELECTRIC COMPANY

1377 HIRD AVE. CLEVELAND, OHIO



For Indoor or Outdoor Use

CLEAN LIGHT

—will be more useful in the industries—
—it will be fresher and brighter when it does not have to fight its way through accumulated dirt.

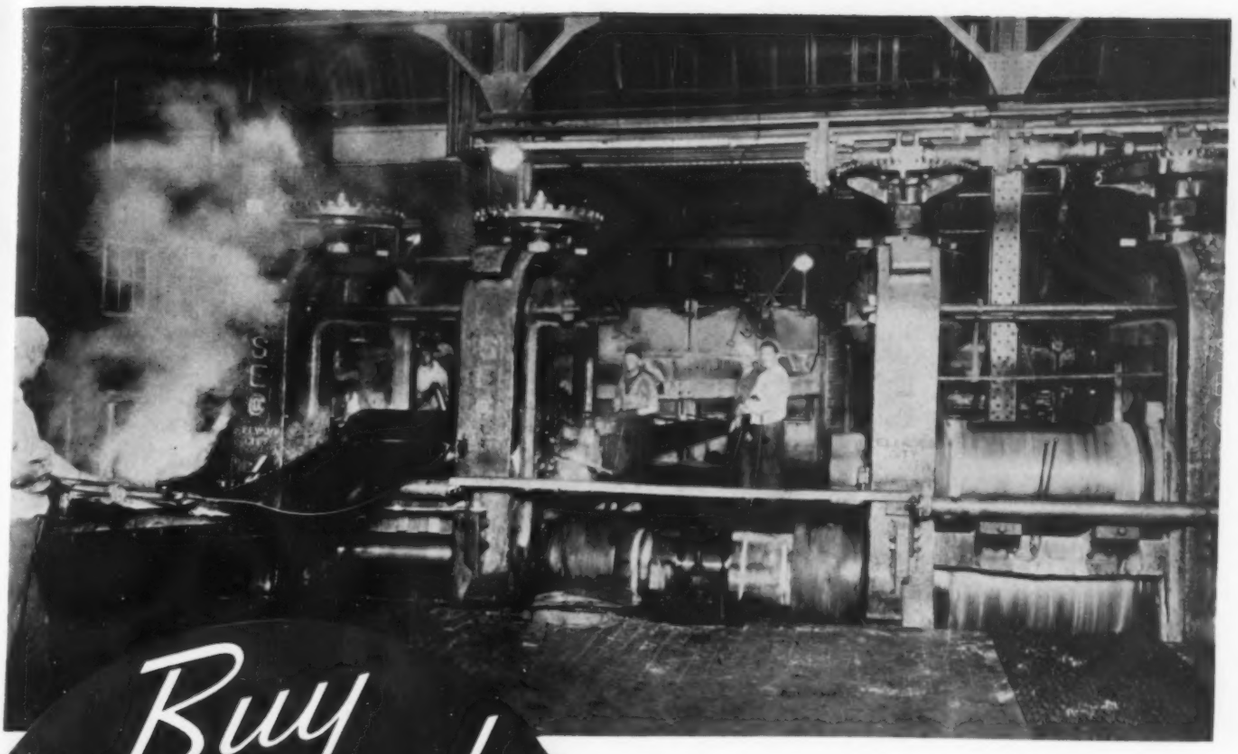
THOMPSON LAMP LOWERING HANGERS

—will help you to keep your lighting equipment clean and useful—
—easy and safe to operate.
—no climbing nor electrical hazards.
—no dangling loops of wire.
—a vast amount of light is lost by dirty reflectors.

Send for descriptive matter and prices.
Handled by leading electrical supply houses.

THE THOMPSON ELECTRIC CO.

1101 POWER AVE., N. E. CLEVELAND, O., U. S. A.



Buy roll neck lubrication

NOT LUBRICANTS

The difference in price between the cheapest and the best roll neck lubricants is absolutely negligible in figuring costs. Life of brasses, savings in power and lubricating labor outweigh all other factors. With Dixon's Roll Neck Lubricants, you will use less lubricant, save much power, prolong life of brasses and reduce lubricating labor. In many cases, the savings exceed $1000 a year. With field equipment developed by Dixon engineers, your savings can be determined in advance—without cost, obligation or inconvenience. Write Dept. RN 18 and details will be sent to you.

SEE THE DIXON EXHIBIT
BOOTH 136, IRON & STEEL ENGINEERS
CONVENTION AND EXHIBITION
DETROIT, SEPTEMBER 22-25 INCLUSIVE

JOSEPH DIXON CRUCIBLE CO.
JERSEY CITY NEW JERSEY

GRAPHITE EXCELLENCE SINCE 1827

DIXON'S GRAPHITE PRODUCTIONS

"and what a help these are"

Send for circulars

GLOWLITES

the Outstanding Signal Lights of the Steel Industry

TYPE A-700

TYPE B-810

New Models Offer Many Advantages

THESE NEW TYPE A-700 and B-810 LINTERN GLOWLITES handle up to 100 watt lamps (using the same lens) making it possible to cover a wider variation of signal requirements. Thus, it is possible to meet maintenance requirements with a smaller stock than were it necessary to carry various size lenses for the different size lamps. They are absolutely weather proof, dust proof and, incidentally, vapor proof.

The special heavy duty lens provided with the new Glowlites has a slightly different prism arrangement than on the earlier types. The signal is much more distinct and is visible at longer distances. It is available in five signal colors and clear, so that in visible signal arrangements a large number of color combinations are possible.

The lens has been designed to give the most effective signal in all directions and the observer is in line with a definite strong light beam, no matter what his angle of vision—a feature not obtainable in any other lens on the market. It combines the features of a fresnel with those of spredlite and semaphore type, so that it meets practically every general signal application.

Exceptionally sturdy units of heavy glass and aluminum construction these Lintern Glowlites combine long life with outstanding signal performance. They are highly efficient units wherever used. Fully described in the new Glowlite Folder. Ask for a copy.

See the Lintern Exhibit, Booth 138, at the Iron and Steel Show

THE *Lintern* CORPORATION

7960 LORAIN AVE. CLEVELAND, OHIO

On heavy duty mill motors, or the smallest auxiliary, it is the BRUSHES that carry the load . .

When you use Le Carbone Brushes you get the standard of uniformity, quality and efficiency in brush performance—a vital contribution to dependable operation of electrical machinery.

Le Carbone, makers of the world's first carbon brush, have over 60 years' experience in production and application of brushes for electrical machinery. Only Le Carbone can offer the widest range of types and grades of brushes, with all that this means in ability to meet individual operating needs correctly.

LE CARBONE COMPANY

BOONTON, NEW JERSEY

New York • Pittsburgh • Chicago • St. Louis • San Francisco

★LE CARBONE BRUSHES

IRON & STEEL EXPOSITION · SPACE 91

DETROIT

TRICO

REG. U S. PAT. OFF.

THESE TWO LITTLE DEVILS

BOY AM I SICK! I CAN'T HOLD OUT MUCH LONGER

DIG BIG HOLES IN YOUR PROFIT

BAD CLIPS AND FAULTY FUSES

Here you have the two primary causes of wasted millions of dollars in burnt fuses, clips, ruined material and equipment, plus enormous loss in production caused by unnecessary blowing of fuses and tremendous waste of current due to excessive heating. "Doubling up" fuse links in a frantic effort to cure the situation only increases fire and accident hazards. Switching from one fuse to another is adding expense unless you switch to a *different* fuse—a fuse with a *powder-packed* element. And you surely cannot eliminate trouble by installing mechanical devices with a multitude of delicate parts.

THERE IS ONLY ONE REMEDY GUARANTEED TO GIVE QUICK AND SATISFACTORY RESULTS—

INSTALL

AND WE FEEL FINE— NO JOB IS TOO TOUGH FOR US

TRICO FUSES and KLIPLOK CLAMPS

TRICO Fuses were expressly designed to accommodate only the correct TRICO Renewal Element with a superior time-lag that only powder-packed elements can give. "Foreign links" cannot be used. It is this *non-interchangeable tamper-proof* feature that assures safe and dependable protection year after year.

KLIPLOK Clamps should be installed on new and old equipment as quickly as possible. They literally bolt the parts together. You can feel the destroying temperature disappear a few moments after they are installed. Performance records show that KLIPLOKS pay for themselves over and over again.

TRICO FUSE MFG. CO. Dept. M MILWAUKEE, WIS., U.S.A.

IN CANADA—IRVING SMITH & CO., MONTREAL

COLORTOP FUSES
COLOR TELLS SIZE

OPTO-MATIC OILERS
SAVE OIL AND BEARINGS

FUSE PULLERS
NON-BREAKABLE

RENEWABLE FUSES
WITH
NON-INTERCHANGEABLE TAMPER-PROOF POWDER-PACKED ELEMENTS

ONE-TIME FUSES
BUILT FOR SERVICE

DRIP-DROP OILERS
SAVE OIL AND BEARINGS

KLIPLOK CLAMPS
SAVE FUSES AND CLIPS

PREFERRED FOR QUALITY

Gatke
Gatke Hoop Mill Bearing— 8" Neck
Gatke Moulded Bottom Bearing used on Billet Mill — 18" Neck
Gatke Moulded Slipper Bearing used for Universal Coupling
Gatke Rail Mill Bearing—18" Neck

MOULDED

Gatke Bearings

NON-METALLIC

for every STEEL MILL SERVICE

GATKE Moulded Non-Metallic Bearings substantially reduce lubricating and replacement costs, yet the greatest saving is effected thru the reduction of power consumption and continuity of service.

A 40" Blooming Mill, completely Gatke equipped, report a life of 200,000 tons with Gatke Bearings (they are still in service), as against 30,000 tons with babbit; 20% saving in power, and elimination of bearing lubrication while the mill is in operation.

Why not get this economy in YOUR mill? The investment is low. There is a Gatke Bearing for every type of Rolling Mill service.

Gatke engineers will gladly make bearing application surveys without obligation.

Gatke

PIONEERS IN MOULDED NON-METALLIC BEARINGS

GATKE CORPORATION . . CHICAGO, ILLINOIS

NELOY GEARS

Increase Wear Life • *Reduce Repair Bills*

LIQUID QUENCHED
NELOY TREATMENTS
1 TO 9 INC.

ANNEALED
STATE

FRACTURED GEAR TEETH Showing the Grain Structure of "NELOY" Steel. Torch Hardening Gives Hardness On Wearing Face and Maintains High Core Value at Center and Root of Tooth.

TORCH HARDENED
"NELOY" 10-A AND B

"NELOY STEEL"

Meets the demand for higher physical values through our metallurgical control from raw material to finished products.

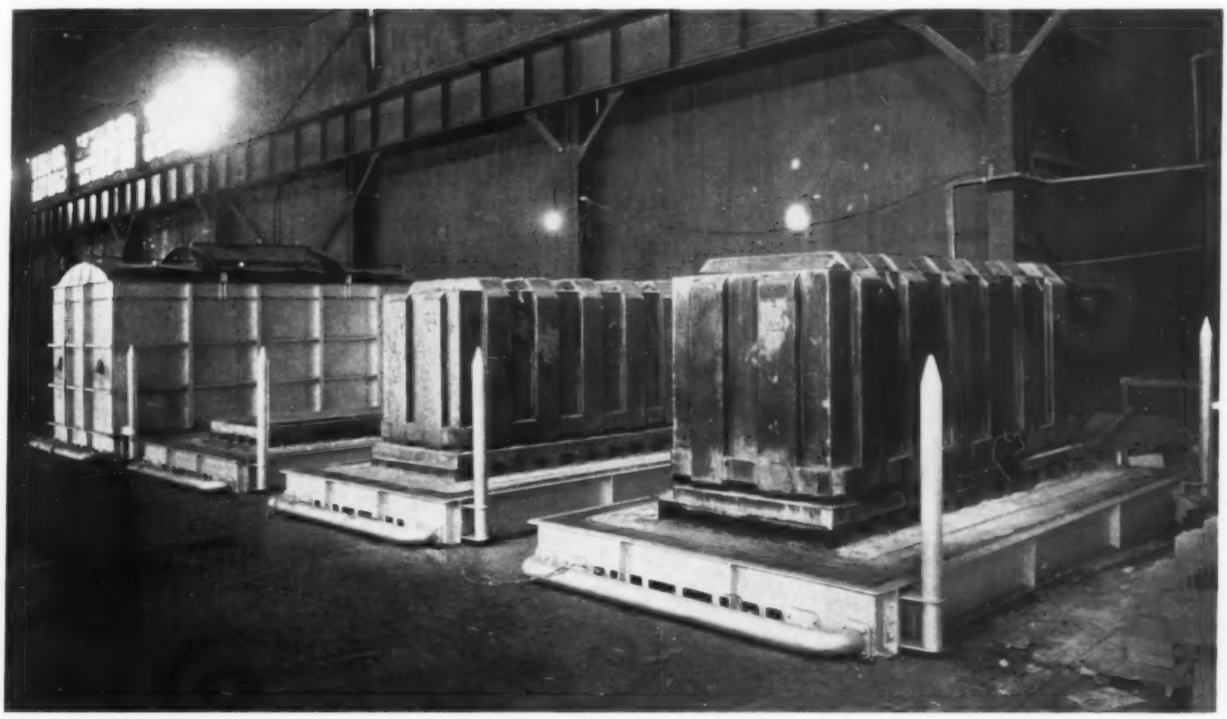
Your copy of our Bulletin No. 2 is ready. SEND FOR IT!

UNIVERSALLY USED BY THE INDUSTRY

NATIONAL-ERIE CORPORATION
ERIE, PENNA.

Something New

in Annealing Furnaces for Sheets and Tin Plates



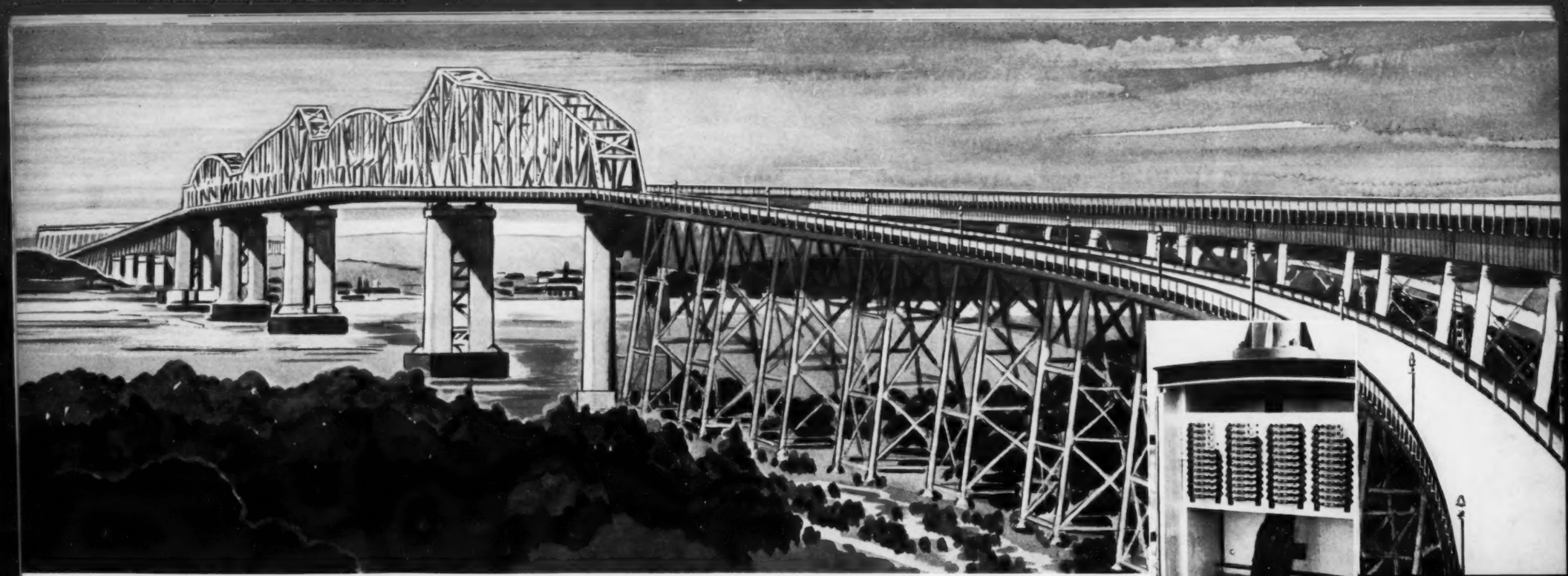
CONTINENTAL ROLL and STEEL FOUNDRY CO.

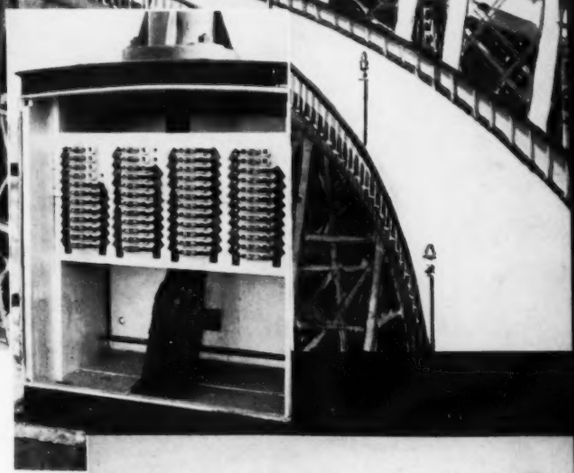
EAST CHICAGO, INDIANA.

Manufacturers of
Steel, Alloy Steel and Iron Rolls
Miscellaneous Steel and Alloy Steel Castings
Rolling Mill Machinery
Machine Work

MEET US AT
BOOTH 82

Plants at
Coraopolis, Pa.
East Chicago, Ind.
Wheeling, W. Va.





The Longest Railroad Bridge in the World . . . .

The Mississippi River Bridge at New Orleans

ON THIS as on many other monumental structures our products were chosen for wiring of interlocking, automatic signals, and lighting circuits.

The Okonite Company and its affiliates have constantly kept step with the advance of the electrical art by research and continually increasing manufacturing facilities, and are fully able to meet your wire and cable problems whether large or small.

THE OKONITE COMPANY

Founded 1878

and

HAZARD INSULATED WIRE WORKS DIVISION

THE OKONITE-CALLENDER CABLE COMPANY, INC.

EXECUTIVE OFFICE: PASSAIC, N. J.

New York
Philadelphia

Boston
Pittsburgh

Chicago
Washington

Detroit
San Francisco

QUALITY
LEWIS rolling mill equipment progresses with the requirements of the steel industry.
QUEEN MARY
LEWIS WELDED BASE FOR MILL GEAR DRIVE.
LEWIS
LEWIS FOUNDRY & MACHINE CO.
PITTSBURGH, PA.

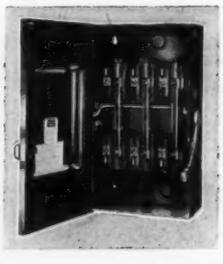
EXECUTIVE OFFICE: PASSAIC, N. J.
New York
Philadelphia
Boston
Pittsburgh
Chicago
Washington
Detroit
San Francisco

We Build Colt-Noark Heavy Duty Switches just like they build battleships!

WHEN you install a Heavy Duty Safety Switch, you expect it to take every type of punishment without a whimper — stand the gaff day in and day out. That's why Colt-Noark Type A Switches are built with extra ruggedness — extra strength — and with strong, efficient Quadbreak and Dualbreak mechanisms. When you specify Quadbreak or Dualbreak — you're getting a lot for your money.

Use Quadbreak and Dualbreak . . . . for Strength-Efficiency-Long Life!

Colt-Noark Type A Switches in 250 Volt are Dualbreak as shown at left. In 575 Volt they are Quadbreak. Unit block construction — self wiping blades — roomy cabinets — plenty of knockouts — quick make and quick break — interlocking covers.



Colt-Noark Type A Weatherproof and Dust Tight Switches are Dualbreak. Rugged Cast Iron cabinets — interlocking covers securely fastened to cabinets by wing nuts — with rubber sealing gasket. 250 and 575 volts — fusible and non-fusible.

The new, complete Colt-Noark Catalog is now ready. Full details on Safety Switches — Weatherproof Switches — Meter and Entrance Switches — Motor Starting Equipment — Fuses — Cast Iron Boxes.

Send for your copy. Ask for Catalog 59.

COLT'S PATENT FIRE ARMS MFG. CO., ELECTRICAL DIVISION HARTFORD, CONN.

Boston, New York, Chicago and Philadelphia. H. B. Squires Co., Pacific Coast Representative

1836 COLT 1936

COLT-NOARK

SWITCHES - MOTOR STARTERS - FUSES

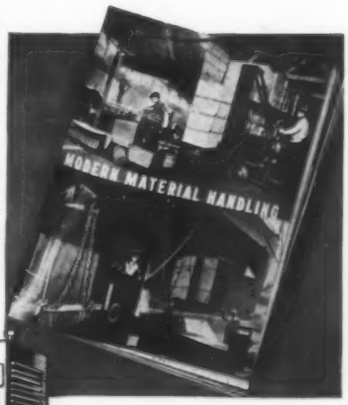
100 Years of Manufacturing Experience is back of Every Colt Built Product

Industry has found a GIANT

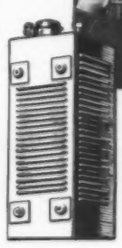
With markets clamoring for more manufactured output, many industries are raising the over-all capacity of existing facilities by more extensive use of that modern giant—the battery industrial truck.

These trucks keep material on the move without congestion—feed machines with work and take it away as fast as machines and men can operate. They are truly giants ...can handle burdens up to 75 tons...load and unload themselves, thus dodging the work of needless rehandling. But they have a vulnerable point...

The power unit. Therefore industry tends more and more to standardize on Edison Steel-Alkaline Batteries in the power box. They are not subject to unexpected failure. Their performance is predictable. They do not give off gas fumes, require repairs, sulphate or break. Only the Edison is built of steel; only the Edison uses non-corrosive alkaline electrolyte; all other batteries made in this country are the lead-acid types. Edisons live 2 to 5 times as long; cost least per year; keep production flowing. Industry uses more Edison Batteries than all other makes combined.

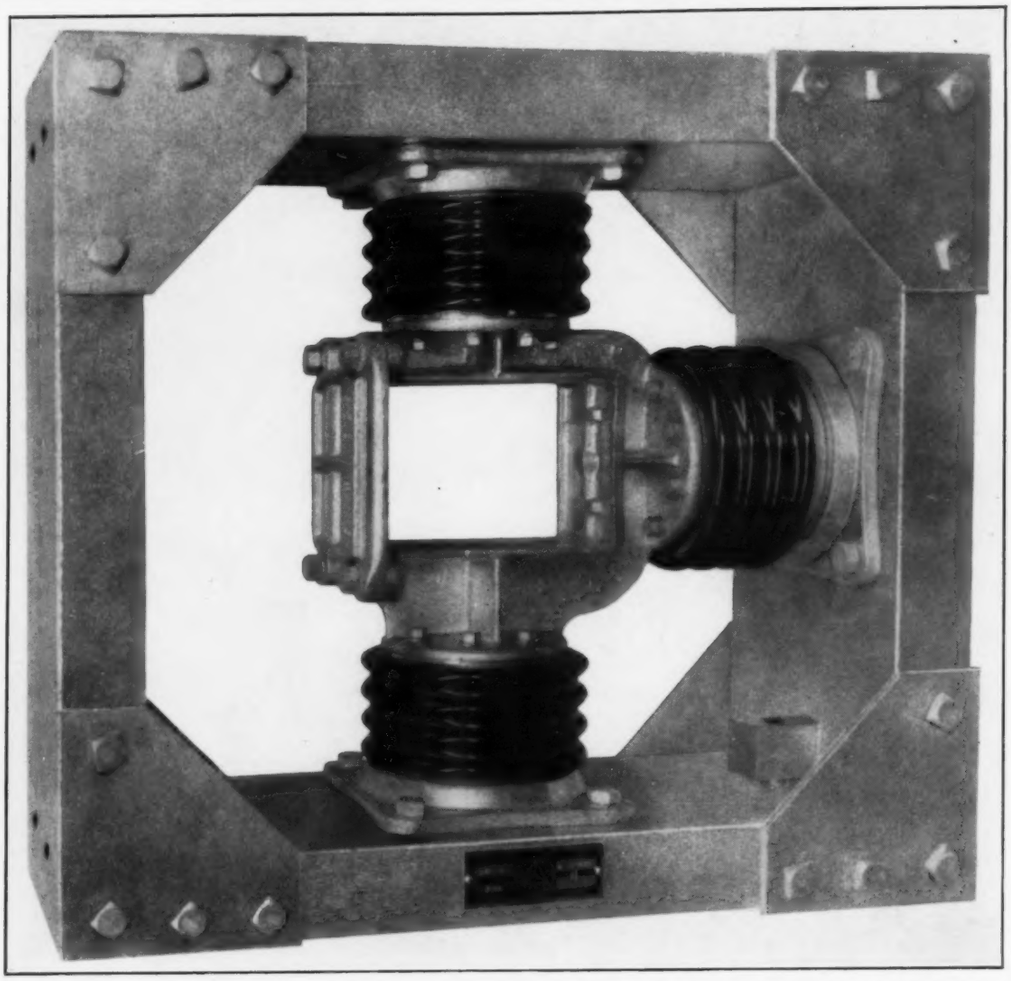


Just out! An authoritative data book on modern materials handling. Your copy is ready. Send for it now!

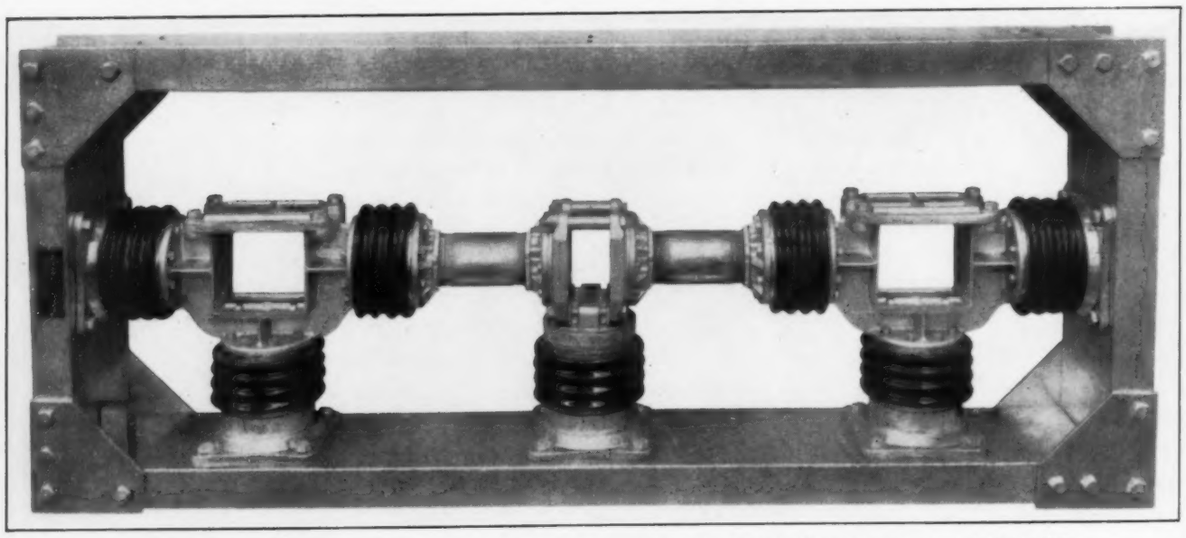


EDISON storage BATTERY

DIVISION OF THOMAS A. EDISON, INC., WEST ORANGE, N. J.



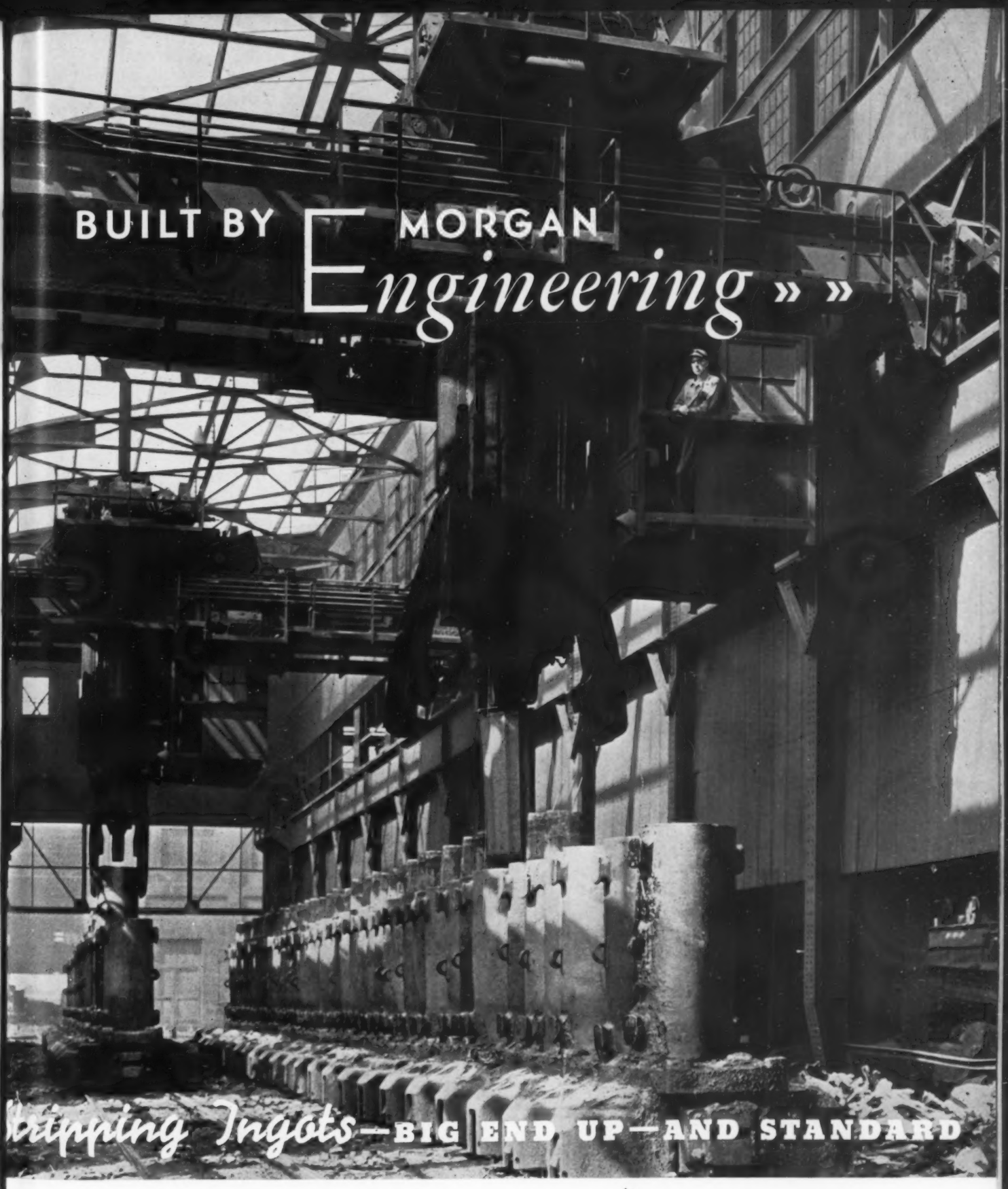
HEAVY DUTY STEEL-CLAD SUPPORT FOR D.C. STEEL MILL SERVICE



ANOTHER ASSEMBLY FOR HEAVY DUTY STEEL MILL D.C. SERVICE

(Ask for data) **Delta-Star Electric Co** *(Ask for prices)*

CHICAGO, ILLINOIS



Two of the Morgan 150-ton, 73'6" an, screw type Ingot Strippers at work ipping standard and big-end-up ingots a northern Ohio mill. Efficient, rugged, pendable—such huge machines play an portant part in stepping up steel pro- ction to meet demands of the blooming ills. Morgan Engineering has designed d developed strippers to perform three distinct stripping operations without making changes in the stripping unit. Today this machine is designed to (1) strip small-end-up or standard ingots; (2) strip big-end-up ingots; (3) break small-end-up ingots loose from stools. Faster, more easily controlled than older machines but built to the same high standards of Morgan Engineering integrity.

★

★

★

★

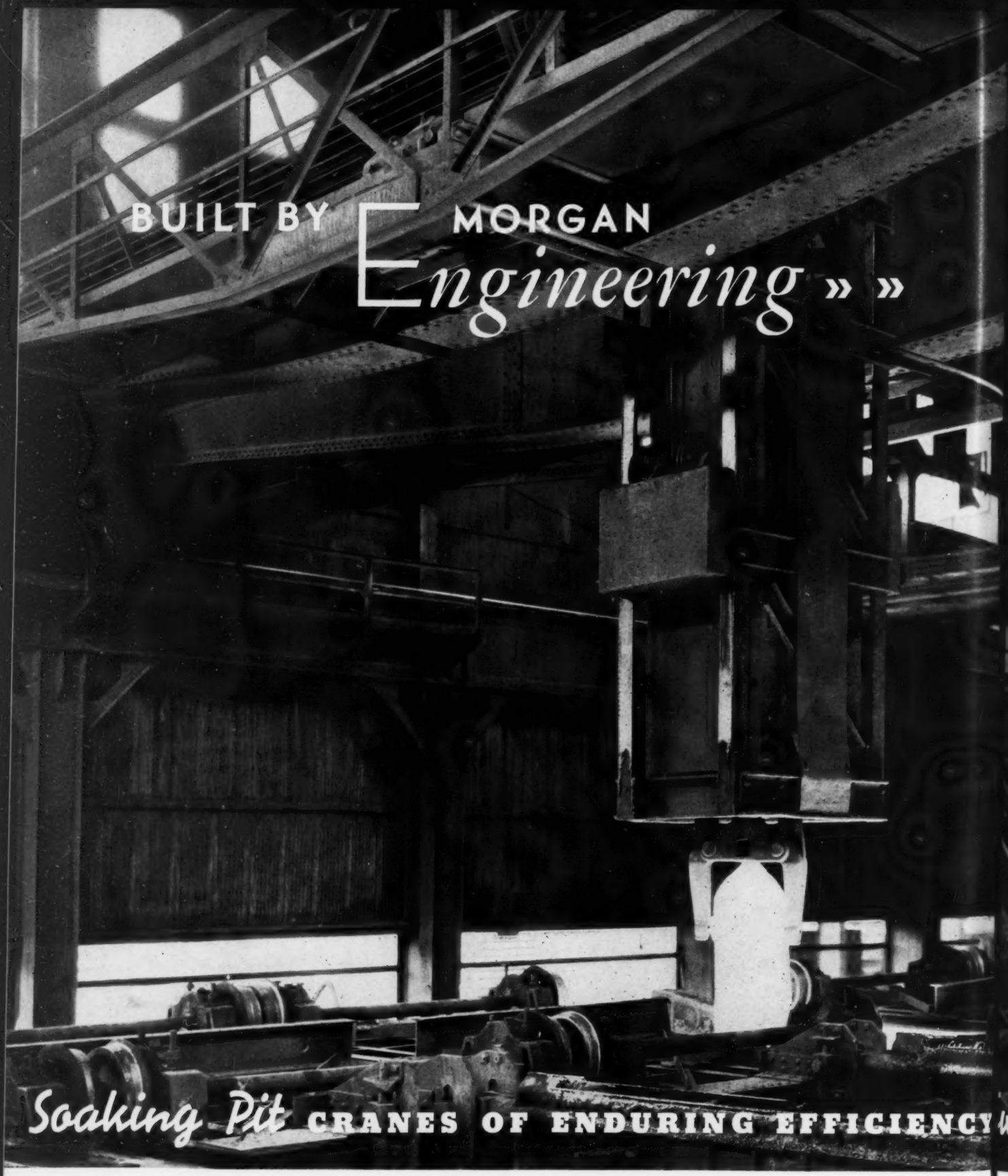
★

DESIGNERS • MANUFACTURERS • CONTRACTORS

BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS
ELECTRIC TRAVELING CRANES • CHARGING MACHINES
INGOT STRIPPING MACHINES • SOAKING PIT CRANES
ELECTRIC WELDED FABRICATION • LADLE CRANES
STEAM HAMMERS • STEAM HYDRAULIC FORGING
PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

THE MORGAN ENGINEERING CO., Alliance, Ohio

Pittsburgh, 1420 Oliver Bldg. New York, 11 W. 42nd Street



● In over 55 years of experience, Morgan Engineering has had the opportunity to observe, eye-to-eye with its customers, the actual lifetime of the huge machines required in making steel. Longevity of service life is of course predicated upon sound engineering, the best materials and correct fabrication methods. Morgan cranes 40 years old and over are in operation today—slower, less efficient than a modern Morgan crane of latest type—but still operating with their original responsibility. Here is a Morgan 10-ton, 73′6″ span, modern Soaking Pit crane in an Ohio steel mill, equipped with worm-operated trolley and anti-friction bearings.

★

★ **DESIGNERS • MANUFACTURERS • CONTRACTO**

★ BLOOMING MILLS • PLATE MILLS • STRUCTURAL MI

★ ELECTRIC TRAVELING CRANES • CHARGING MACHIN

INGOT STRIPPING MACHINES • SOAKING PIT CRA

★ ELECTRIC WELDED FABRICATION • LADLE CRA

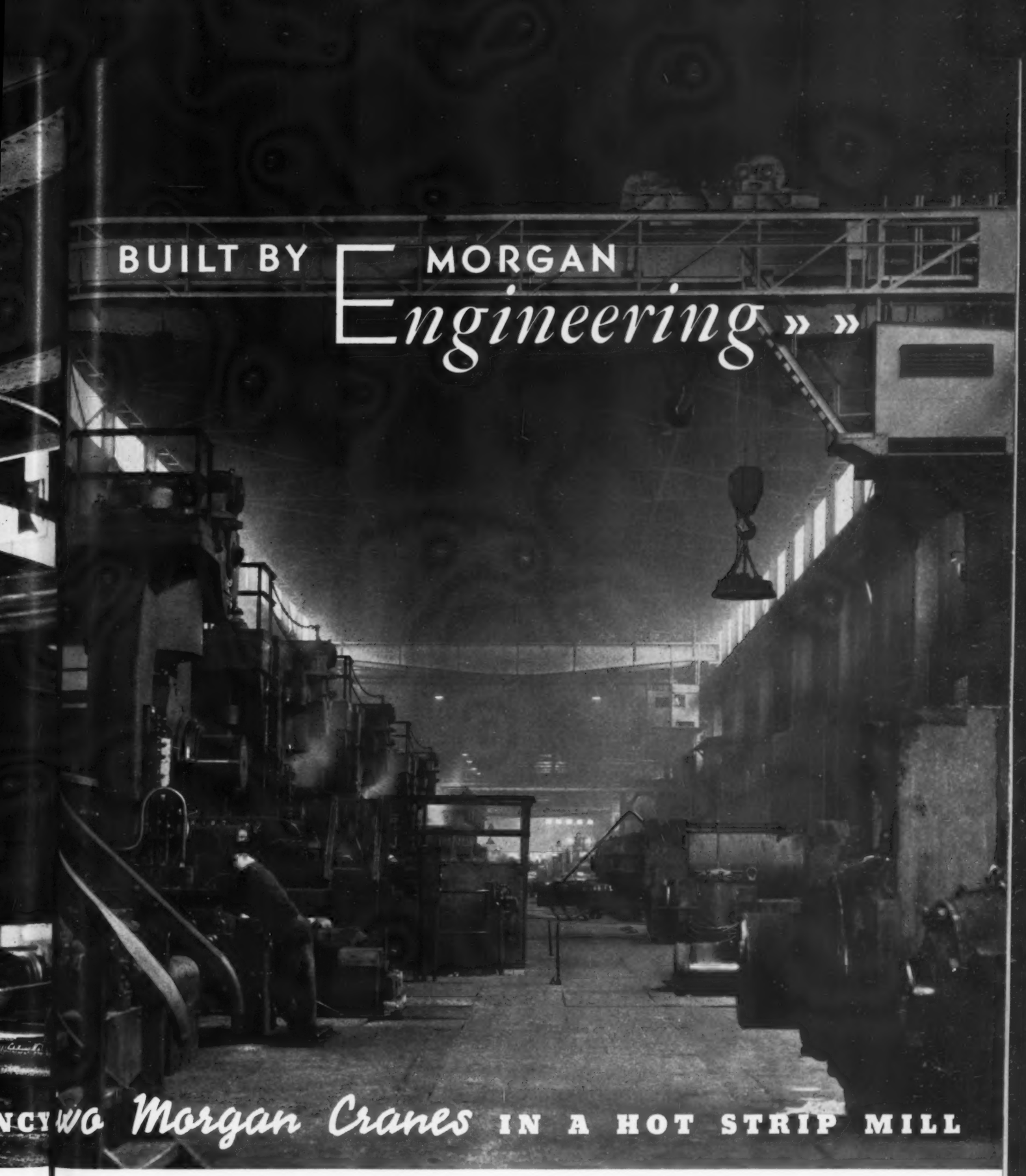
STEAM HAMMERS • STEAM HYDRAULIC FORGI

★ PRESSES • SPECIAL MACHINERY FOR STEEL MI

THE MORGAN ENGINEERING CO., Alliance, O

★ Pittsburgh, 1420 Oliver Bldg. New York, 11 W. 42nd St

★



wo 60-ton, 79′8″ span Morgan cranes ing a hot strip mill are shown here, ngsters in service now but because of itional Morgan stamina of design construction, sure to render many s of profitable service. Pioneer build- f heavy duty steel mill cranes, Morgan ineers are alert to accept the newest, ed advances in crane construction, many of which originate with Morgan. Steel mill capital investment, such as the purchase of cranes represents, is based upon known factors of safety and efficiency—and the Morgan reputation for unswerving integrity. These requirements Morgan Engineering has always met and always will meet, with 55 years of experience as a background.

★

★ **DESIGNERS • MANUFACTURERS • CONTRACTORS**

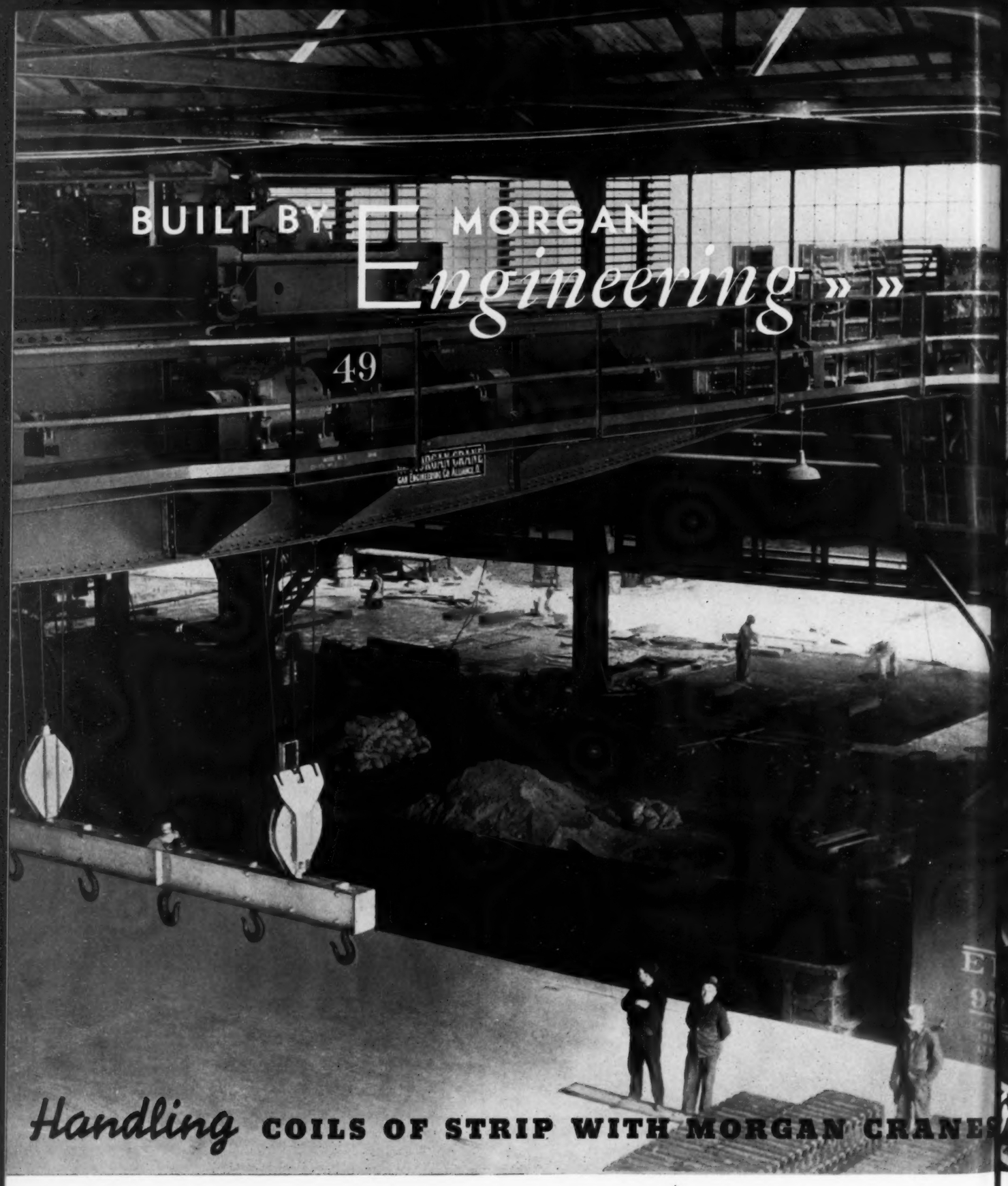
★ BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS
ELECTRIC TRAVELING CRANES • CHARGING MACHINES

★ INGOT STRIPPING MACHINES • SOAKING PIT CRANES
ELECTRIC WELDED FABRICATION • LADLE CRANES

★ STEAM HAMMERS • STEAM HYDRAULIC FORGING
PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

★ **THE MORGAN ENGINEERING CO., Alliance, Ohio**
Pittsburgh, 1420 Oliver Bldg. New York, 11 W. 42nd Street

★



Handling COILS OF STRIP WITH MORGAN CRANES

● Here is one of an installation of six Morgan 15-ton, double hook, Coil Handling Cranes in a large steel mill. One group of three has a span of 105′2″ each, the other group of three has a span of 110′6″ each. All are equipped with welded fabricated trolleys and bridge trucks, most efficient type brakes and anti-friction bearings throughout. All have every known safety device. In building cranes for 55 years, Morgan Engineering has acquired through close association with the steel industry a thorough knowledge of how important to profit it is that there is no skimping in any detail of construction. Morgan does not build all the cranes used by the heavy industries, but it will always build the strongest ones.

★

★ **DESIGNERS • MANUFACTURERS • CONTRACTO**

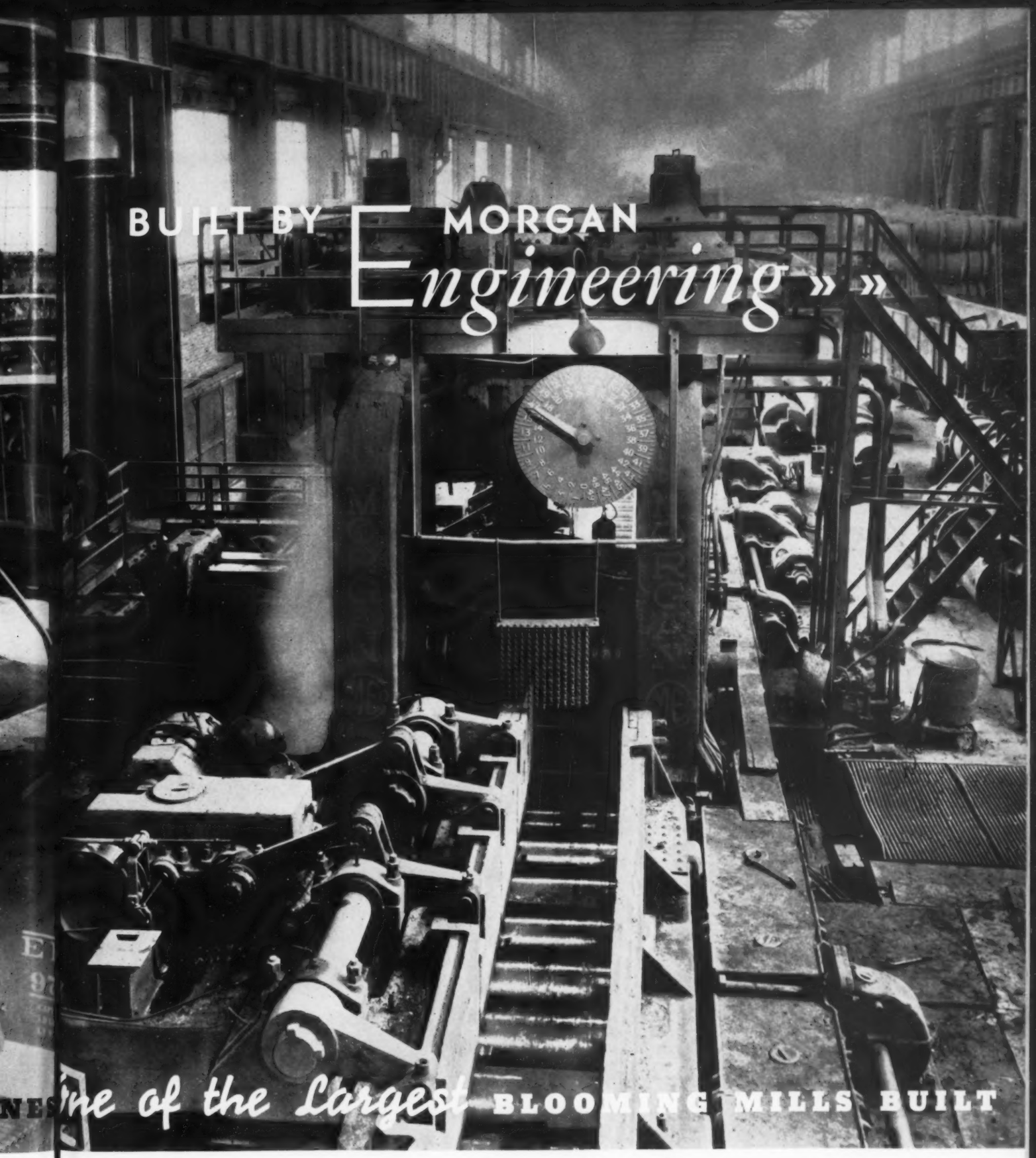
★ BLOOMING MILLS • PLATE MILLS • STRUCTURAL MI
ELECTRIC TRAVELING CRANES • CHARGING MACHIN

★ INGOT STRIPPING MACHINES • SOAKING PIT CRA
ELECTRIC WELDED FABRICATION • LADLE CRA

★ STEAM HAMMERS • STEAM HYDRAULIC FORGI
PRESSES • SPECIAL MACHINERY FOR STEEL MI

★ **THE MORGAN ENGINEERING CO., Alliance, O**
Pittsburgh, 1420 Oliver Bldg. New York, 11 W. 42nd St

★



Few blooming mills have been built ring the past ten years, but this is one the largest ever built and one of the west. This 54″ blooming mill has one-ece steel castings for its housings, uring rigidity. A two-cylinder roll ance allows for minimum headroom. nipulator is of the over-head type, compact and accessible. Finger lifts and side-guards, each operated by two motors in series, assure quick acceleration and more tonnage. Morgan responsibility extends from design to construction and installation–assuring mill operators of satisfactory production as specified, and traditional integrity of Morgan engineering.

★

★

★

★

★

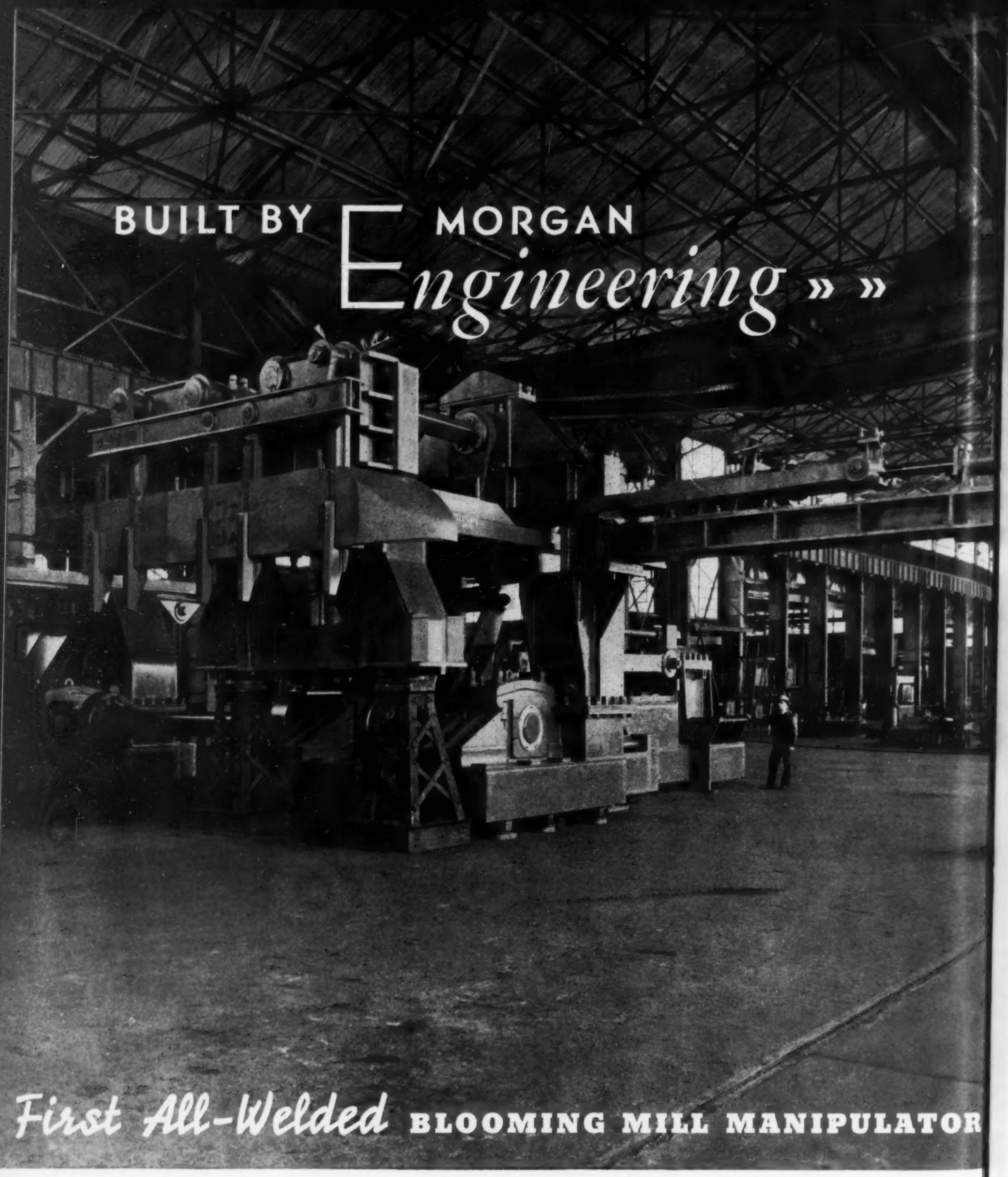
★

DESIGNERS • MANUFACTURERS • CONTRACTORS

BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS
ELECTRIC TRAVELING CRANES • CHARGING MACHINES
INGOT STRIPPING MACHINES • SOAKING PIT CRANES
ELECTRIC WELDED FABRICATION • LADLE CRANES
STEAM HAMMERS • STEAM HYDRAULIC FORGING
PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

THE MORGAN ENGINEERING CO., Alliance, Ohio

Pittsburgh, 1420 Oliver Bldg. New York, 11 W. 42nd Street



First All-Welded BLOOMING MILL MANIPULATOR

● Fabricated from rolled steel plates by arc-welding, actuated hydraulically, this blooming mill manipulator was built by Morgan Engineering for a new 44-inch 2-high reversing blooming mill in the Pittsburgh district. Ingots weighing up to 25,000 pounds are handled by this manipulator. It has four movable platens, with a stroke of 7′6″, two in front and two in rear of mill. Five tilting fingers, each with a lift of 3′6″ are provided on one of the front manipulator heads. On such equipment for modern steel production the rugged stability of Morgan Engineering is well established, long since proved by the largest producers.

★

★

★

★

★

DESIGNERS • MANUFACTURERS • CONTRACTO

BLOOMING MILLS • PLATE MILLS • STRUCTURAL MIL

ELECTRIC TRAVELING CRANES • CHARGING MACHIN

INGOT STRIPPING MACHINES • SOAKING PIT CRAN

ELECTRIC WELDED FABRICATION • LADLE CRAN

STEAM HAMMERS • STEAM HYDRAULIC FORGI

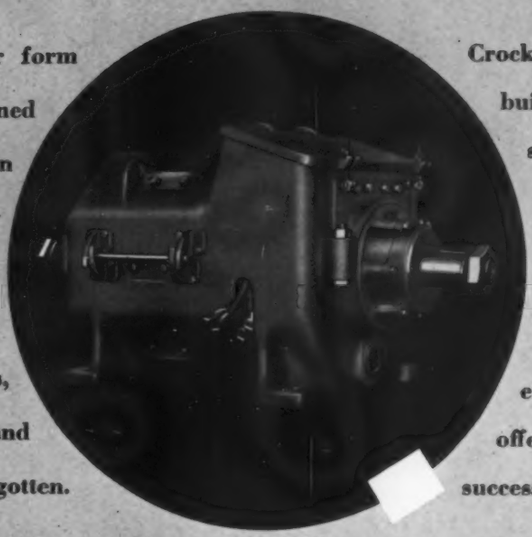
PRESSES • SPECIAL MACHINERY FOR STEEL MI

THE MORGAN ENGINEERING CO., Alliance, Oh

Pittsburgh, 1420 Oliver Bldg. New York, 11 W. 42nd St

Just the MOTOR *for* TOUGH JOBS

The Crocker-Wheeler form "SW" motor is designed for auxiliary drives in iron and steel mills—for the tough jobs. It is a mill motor, built to standardized dimensions, that can be installed—and then can be safely forgotten.



Crocker-Wheeler has been building motors for iron and steel mill use for thirty-two years. The experience gained during these years together with the reputation of the Company for excellent engineering, offer a true guarantee of successful motor operation.

CROCKER-WHEELER ELECTRIC MFG. COMPANY

Main Office and Works: AMPERE, N. J.

Sales Offices in principal cities

CROCKER-WHEELER

EXCELLENT ENGINEERING

"THESE MACHINES MUST MEET ANY EMERGENCY

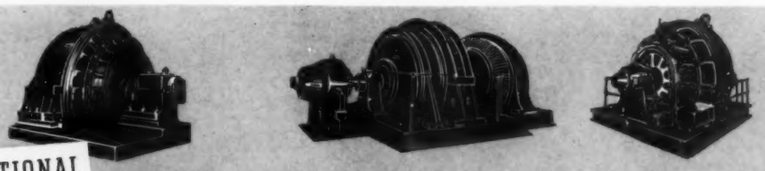
specify "SA" BRUSHES"

● Electrical equipment must be designed to meet any emergency — sustained overloads, sudden peaks or heavy mechanical shocks. Modern industry will not put up with failure. The Steel Industry *DARE NOT* take chances with failure.

The designing engineer carefully considers every element entering into the product he is creating. There must be no weak point. Every part must be capable of meeting the emergencies of heavy duty service. That is the reason designing engineers specify "SA" Series Brushes.

That is also the reason electrical superintendents, who have tried them, specify "SA" Series grades for steel mill equipment.

They have proved for others their ability to meet emergencies . . . Let Them Prove It For You!



THERE IS A NATIONAL CARBON BRUSH FOR EVERY CLASS OF SERVICE

Visit Our Booth, Nos. 128 and 181, Iron and Steel Exposition, Detroit, Sept. 22-25

NATIONAL CARBON COMPANY, INC.

Carbon Sales Division, Cleveland, Ohio

Unit of Union Carbide UCC and Carbon Corporation

BRANCH SALES OFFICES: New York - Pittsburgh - Chicago - San Francisco

PHOENIX ROLLS IN SERVICE

Many years of yesterdays have gone into research to make Phoenix Rolls what they are today—tough, strong and long enduring in service—designed to reduce your roll problems to the irreducible minimum. It is to your advantage to specify PHOENIX Rolls.

PHOENIX ROLLS

PHOENIX STEEL, for unusual strength; PHOENIX "A" (steel alloy), for strength and wear; PHOENIX METAL—PHOENIX "K", for strength, wear and finish; PHOENIXLOY (uniformly hard), for flat rolling where high finish of extremely thin gauge of material is required to be free from all marks or defects. PHOENIX CHILL; PHOENIX NICKEL CHILL; for all flat rolling requiring finish. Also tube mill rolls of quality material best suited to the kind of service required.

PITTSBURGH ROLLS CORPORATION

PITTSBURGH, PA.

FOR LONG DEPENDABLE SERVICE SPECIFY DELTABESTON MAGNET WIRE

3 EXCLUSIVE FEATURES

- PURIFIED ASBESTOS
- FELTED ASBESTOS INSULATION
- GLYPTAL BONDING

Deltabeston Magnet Wire is ideal for all types of electro-magnetic windings—the best that money can buy. It is the only magnet wire insulated with purified asbestos solidly bonded to the copper with a heat-resisting Glyptal Varnish. By an exclusive process the asbestos fibers are felted into a completely intertangled, compressed tube and coated with Glyptal. Deltabeston Magnet Wire insulation goes through many more refining processes than any other magnet wire insulation does. The result is a tough, flexible insulation with greater dielectric strength and resistance to heat, moisture and acids. Conclusive tests have proved that Deltabeston Magnet Wire will operate satisfactorily in temperatures up to 175 degrees C.

Test for yourself the superior features of Deltabeston Magnet Wire. For samples and complete information write to Section Y-649, Appliance and Merchandise Department, General Electric Co., Bridgeport, Conn.

GENERAL ELECTRIC

DELTABESTON MAGNET WIRE

APPLIANCE AND MERCHANDISE DEPARTMENT, GENERAL ELECTRIC COMPANY, BRIDGEPORT, CONN.

LEVER BROS.

VIRGINIA ELECTRIC CO.

HAMMERMILL PAPER CO.

LYNN GAS AND ELECTRIC CO.

STANDARD OIL of CALIFORNIA

For all of the above new boiler installations

STURTEVANT DRAFT FANS

SELECTED BY STONE & WEBSTER ENGINEERING CORP.

And here are a few more of the many other users:

Edison Electric Illuminating Co. of Boston
Brooklyn Edison Company
New York Edison Company
Philadelphia Electric Company
Cleveland Electric Company
Ohio Power Company
State Line Generating Company
Pacific Gas & Electric Company
Union Gas and Electric Company
American Gas & Electric Company
United Illuminating Company
United States Rubber Company
West Virginia Pulp & Paper Company
Tennessee Coal, Iron & R.R. Co.
Hartford Electric Light Company
Puget Sound Power and Light Co.
Ford Motor Company

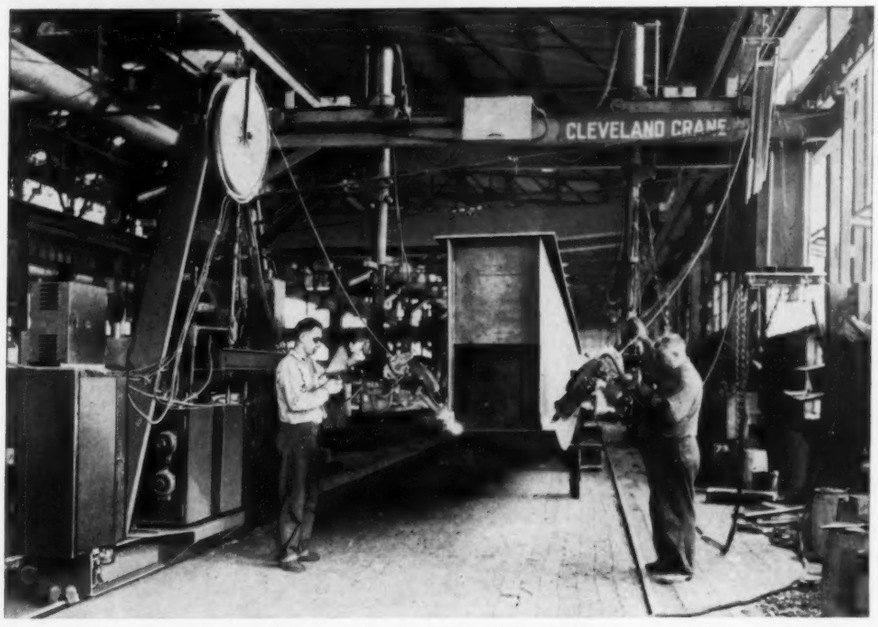
B. F. STURTEVANT CO., Hyde Park, Boston, Mass. *Branches in 40 Cities* B. F. Sturtevant Co. of Canada—Galt, Toronto, Montreal

Sturtevant *Puts Air to Work*

REG. U. S. PAT. OFF.

Photo shows Sturtevant Draft Fan with patented vane control

ALL WELDED STEEL MILL CRANES

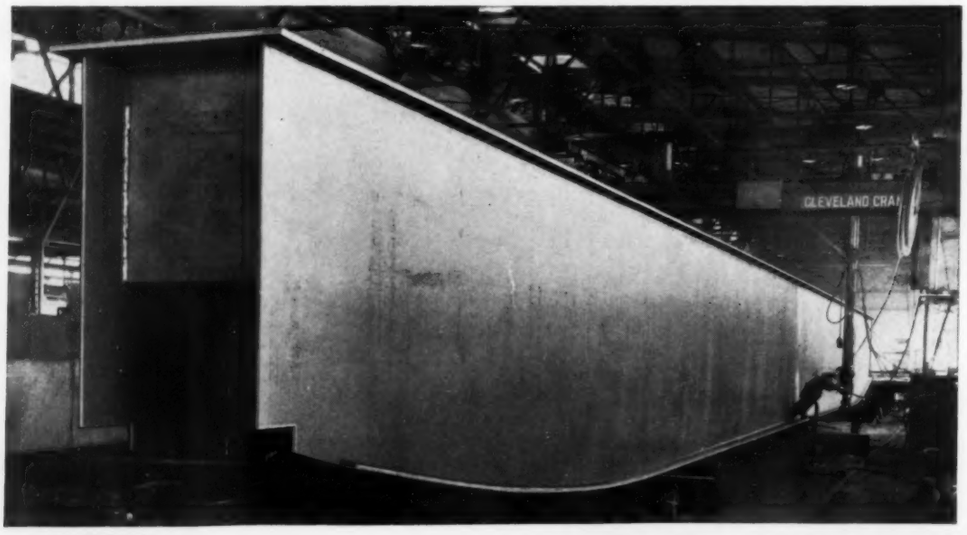


AGAIN

Another Step Ahead that makes Cleveland Welded Cranes Even Better

NOW — Welded girders by the continuous automatic shielded-arc process. A weld metal so closely approaching the physical characteristics of the parent steel that little or no difference can be detected.

Name your factor of safety — we will give it to you with less weight.



CLEVELAND TRAMRAIL
OVERHEAD MATERIALS HANDLING

CLEVELAND CRANES

THE CLEVELAND CRANE & ENGINEERING CO.
WICKLIFFE OHIO
NEW YORK · DETROIT · PITTSBURG · CHICAGO

Uptegraff Transformers

Three Uptegraff Transformers, 1000 KVA, 25 cycle, designed and built for a large steel plant.

FEATURE by feature throughout every Uptegraff Transformer, you find sureness in design and highest grade materials. Uptegraff quality and service are the way to Transformer satisfaction.

Standard Distribution
Current and Potential
Reactance Coils

Subway
Dry Type
Power
Rural

R. E. UPTEGRAFF MFG. COMPANY

300 No. Lexington Avenue, PITTSBURGH, PA.

DON'T GUESS—MISTAKES ARE COSTLY!

For Right Answers SEE THIS BOOK

Procedure Handbook of Arc Welding Design and Practice for Engineers, Designers and Welding Users
New Third Edition Greatly Enlarged . . . Contains 586 Pages . . . Over 700 Illustrations

New Third Edition answers all questions about arc welding. Most complete book of its kind available. Recognized everywhere as the authority on the art of electric welding. Used by prominent engineering schools and thousands of industrial plants in the United States and foreign countries. Previous editions sold out in a few months.

The new Handbook renders all others obsolete. Brings you right up to date on all latest arc welding applications and design procedures. Contains 143 pages of important new data. Read this condensed Table of Contents. It shows the wide scope of the Handbook.

I—Methods and Equipment
II—Technique of Welding
III—Procedures, Speeds and Costs for Welding Mild Steel
IV—Structures and Properties of Weld Metal
V—Weldability of Metals
VI—Arc Welded Steel Construction of Machinery
VII—Designing for Arc Welded Structures
VIII—Typical Applications of Arc Welding in Manufacturing, Construction, Maintenance

Everything necessary for most efficient use of arc welding is included in this book. Don't run a chance of costly mistakes or of not getting most profits when this gold mine of pertinent data is yours for such a small investment.

Postpaid
ONLY $1.50 IN U.S.A.
Foreign Postage 50c extra.

Printed on fine paper with semi-flexible binding of simulated leather, gold embossed; size 6 x 9 inches

The Handbook has saved thousands of dollars for others. It can do the same for you.

Order your copy NOW

Address

IRON AND STEEL ENGINEER

1010 EMPIRE BUILDING PITTSBURGH, PA.

CENTER FIRING - HEAT FOLLOWS PRINCIPAL AXIS OF STOCK

Simple as ABC

* NEW — yet the only right way!

2 × 2 = 4

THE AMCO PIT FURNACE

For the first time a successful recuperative type furnace is offered that embodies continuous center firing through the hearth, and in which the flow of the heated gases of combustion is parallel with the principal axis of the stock.

OPERATING ADVANTAGES

UNIFORM HEATING—increases percentage of finished steel.

WASHING ELIMINATED—correct fuel application—automatically regulated.

BOTTOM MAKING ONCE WEEKLY — saves coke, labor-increases production.

THE AMCO METHOD
(PATENTED)

INCREASED TONNAGE—up too 100%

SEAL TYPE COVER—CRANE TYPE CARRIAGE.

LOWEST FUEL CONSUMPTION IN INDUSTRY

200000 Btu per gross ton hot steel
1400000 Btu per gross ton cold steel
1800000 Btu per hr. holding at 2250 F

CONTROLLED HEAT CIRCULATION

DEPENDABLE RECUPERATION

AVAILABLE AS DIRECT FIRED FURNACE

ADAPTED FOR CONVERSION OF EXISTING PITS

USES ALL FUELS

FUEL SYSTEM FULLY AUTOMATIC

(U. S. and Foreign Patents Allowed and Pending)

* We can't, in the limits of the space, do full justice to this development so we strongly urge those in any way interested in soaking pits to write for detailed information.

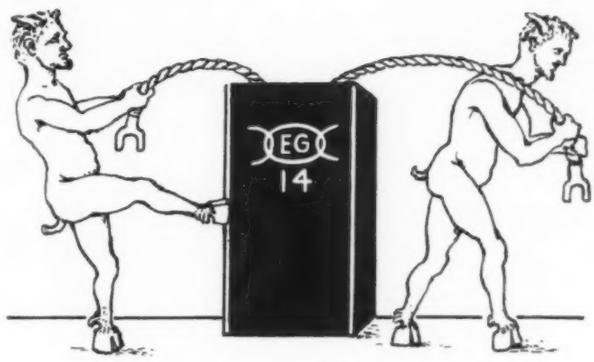
The AMSLER-MORTON Company

Fulton Bldg., Pittsburgh, Pa.

Fours et Fumisterie
Paris

Amco K-T-G
Sheffield, Eng.

STEEL MUST STAND OVERLOAD
MORGANITE WILL STAND OVERLOAD



That's why Steel Mill Operators have specified

Morganite Brushes

for Motors and Generators of new equipments

Booth 175
at Iron and Steel Show

MORGANITE BRUSH CO., Inc.

Long Island City, N. Y.

Branch Office: 9 So. Clinton St., Chicago, Ill.

Alliance

"LARGEST BUILDERS OF THE WORLD'S LARGEST CRANES"

Booth 5

THE
ALLIANCE MACHINE COMPANY
Alliance, Ohio

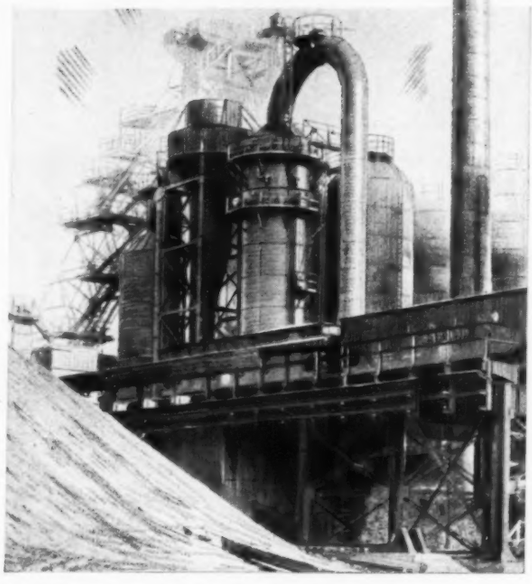
DESIGNERS AND BUILDERS
OF
STANDARD CRANES · LADLE CRANES · GANTRY CRANES · SOAKING PIT CRANES · INGOT STRIPPERS · OPEN HEARTH, SLAB, AND BILLET CHARGING MACHINES · ORE AND COAL BRIDGES · CAR DUMPERS · ROLLING MILL MACHINERY · FORGING MANIPULATORS · DROP FORGE HAMMERS, STEAM AND BOARD · SPECIAL MACHINERY

H. A. BRASSERT & COMPANY

• *Engineers and Contractors* •

FOR THE IRON AND STEEL INDUSTRY

At our Exhibit, Booths Nos. 141 and 168 at the Iron and Steel Engineer's Exposition at Detroit, we will show designs for Blast Furnace and Steel Plant Construction, together with special equipment of our own development as listed below. We invite all members and their friends to visit us on September 22 to 25.



- Brassert-Jeffrey Vibrating Bin Feeder
- Brassert-Fairbanks-Morse Skip Weigher
- Brassert Blast Furnace Bell Hoist
- Brassert Blast Furnace Charging Sequence Control
- Brassert Blast Furnace Revolving Top
- Brassert Blast Furnace Stock Line Recorder
- Brassert Blast Furnace Double Charging Bell
- Brassert Venturi Stock Line
- Brassert Insulated Blast Furnace Blow Pipe
- Brassert Metering System for Air to Blast Furnace Tuyeres
- Henry-Butler Heavy Nosed Blast Furnace Tuyere
- Brassert Blast Furnace Mud Gun
- Brassert Blast Furnace Cinder Notch Stopper
- Brassert Hot Blast Stove Gas Burner
- Brassert Boiler Gas Burner
- Brassert Metal Stove Bottom
- Brassert Hot Blast Stove Checker Systems
- Brassert Hot Blast, Chimney, Mixing and Drop Valves
- Brassert Double V-Type Goggle Valve
- Brassert System for Preliminary and Final Cleaning of Blast Furnace Gas
- Brassert Strainer-Filter for Industrial Water

H. A. BRASSERT & COMPANY
310 South Michigan Avenue • Chicago

more tonnage with VIM TRED

Leather Rod Mill Belts . . . at lower ultimate cost

Steel mills favor VIM TRED because they know from experience that it stands up under heavy duty service. Its greater flexibility and gripping power, its longer fibers and its rugged strength make VIM TRED the choice on rod mill drives and other tough spots.

VIM Leather Packings for operating valves, presses, hydraulic roll lifters, etc., also maintain our guarantee of twice the service of any other leather packing.

Other
HOUGHTON PRODUCTS
of interest to
STEEL MILLS

A New Pickling inhibitor that saves acid and loss of steel, stops fumes, reduces hydrogen brittleness and blisters; stronger and cheaper per pound; leaves a chemically clean surface with whiter finish.
Double Arrow Greases—reversible, stable.
Sta-Put 532—for roll neck bearings.
Sta-Put 591—Open Gear E. P. Lubricant.
PERMASOL R. M.—for cooling and lubricating strip mills.
Metal Cleaners.
Cutting and Threading Oils.

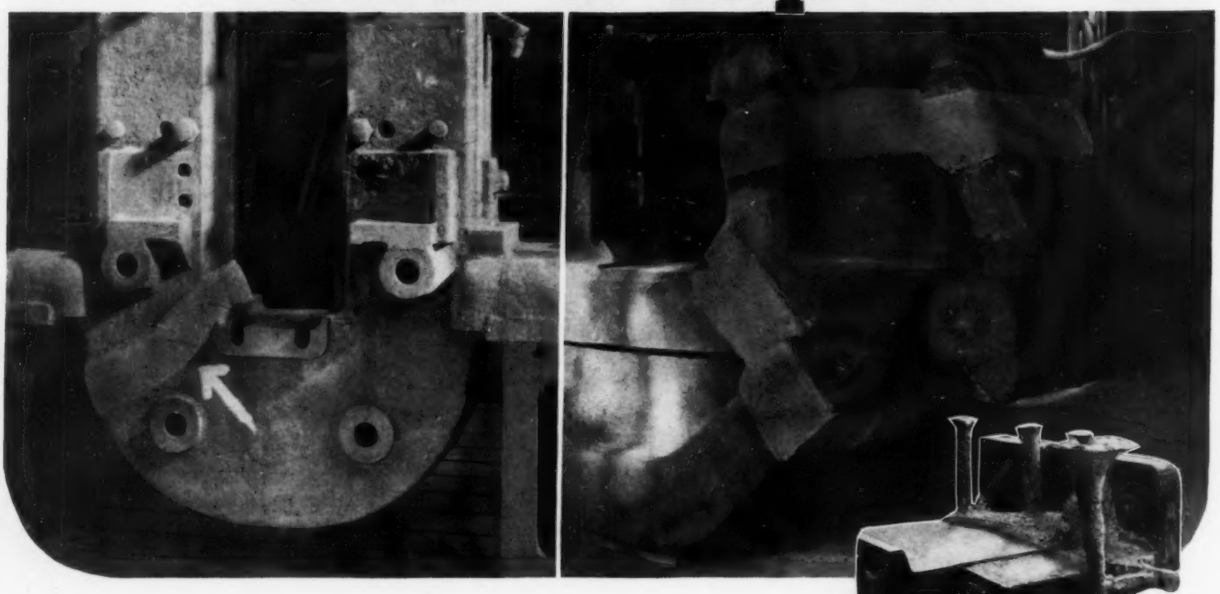
VIM LEATHER "U" PACKING

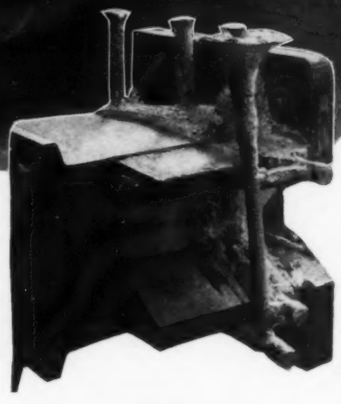
Other steel mill "specialties" standard with Houghton are listed briefly on this page; they are being exhibited at the Iron and Steel Exposition, where you can obtain proof of the superior service they render. See us at the Statler or Booths 214 and 215.

E. F. HOUGHTON & CO.
Chicago - Philadelphia - Detroit

See all these and more, at BOOTHS 214 and 215
IRON AND STEEL EXPOSITION

HERE'S SALVAGE!
. . . with a capital "S"





Thermit Welding has been responsible for tremendous savings to the iron and steel industry. Broken rolls, pinions, housings, manipulator racks and heavy machine frames are salvaged and repaired the Thermit way at a fraction of replacement cost. Further economies are effected by avoiding the long delays and costly shut-downs which almost invariably result when new parts must be cast or forged. Actual savings on individual jobs frequently run to several thousand dollars.

There is every indication that even better times are ahead for the industry. It will pay you to prepare for them now by organizing a Thermit Welding Department. Our engineers, backed by many years of steel mill experience, will be glad to help with this work; to check over your scrapped equipment and report on parts that can be repaired profitably; to keep you posted on new developments in the application of Thermit.

Write today for a copy of the booklet: "Thermit Welding—Industry's Master Maintenance Tool", or, better still, ask to have our nearest representative call and give you the whole story in person.

THERMIT WELDING

METAL & THERMIT CORPORATION, 120 BROADWAY, NEW YORK, N.Y.
ALBANY • CHICAGO • PITTSBURGH • SO. SAN FRANCISCO • TORONTO

THE SEPTEMBER 1935 REPORT
IRON AND STEEL ENGINEER
LISTS

MORE NEW

BANTAM

INSTALLATIONS

OF ROLL NECK BEARINGS

IN THE PRECEEDING

12 MONTHS

THAN

ALL OTHER MAKES

COMBINED

RECENT LISTINGS OF INSTALLATIONS

(Note the large increase

Mill	Type	No. Stands	Roll Sizes Work	Backing	Body	Where Operating	Position of Bearing	Bearing Number	Year Installed
Cold Strip	2 High	1	12½		16	Acme Steel Co., Riverdale, Ill.	Roll Necks	A-1137-A	1934
"	4 High	1	8½	25	22	"	Backing Rolls	A-1138-B	1935
"	"	1	8½	25	22	"	Work Rolls	A- 792-A	1934
Cold Strip	4 High	1	12	30	40	Allegheny Steel Co. Brackenridge, Pa.	Backing Rolls	A-1164-B	1936
Hot Strip	4 High	1	18	40	58	American Rolling Mill Co. Middletown, Ohio	Backing Rolls	A- 690-C	1933
"	"	1	"	"	"	"	" "	A- 926-C	1935
"	"	5	"	"	"	"	Work Rolls	A- 467-B	1932
"	"	2	20	46	80	"	" "	U- 586-B	1936
Cold Strip	4 High	1	14	34	58	American Rolling Mill Co. Ashland, Kentucky	Backing Rolls	R- 212-E	1935
"	"	1	"	"	"	"	" "	A- 448-D	1935
"	"	1	"	"	"	"	" "	A-1187-C	1936
Cold Strip	4 High	3	19	49½	80	American Rolling Mill Co. Middletown, Ohio	Work Rolls	A- 467-B	1936
Cold Strip	2 High	1	24		44	American Sheet & Tin Plate Co. Gary, Indiana	Roll Necks	B-1204-C	1933
"	"	3	28		84	"	" "	B-1236-E	1934
"	4 High	1	20½	56	84	"	Backing Rolls	A- 412-C	1933
"	"	1	"	"	"	"	" "	A- 937-E	1935
"	"	1	"	"	"	"	" "	A-1183-D	1936
"	"	1	"	"	"	"	Work Rolls	A- 417-B	1933
Cold Tin Plate	"	1	16	49	42	"	Backing Rolls	U- 265-D	1933
"	"	1	"	"	"	"	" "	A-1254-D	1936
Cold Strip	Cluster	1	7¼	14½	18	"	" "	B-1412-B	1934
"	4 High	1	16½	32	84	"	" "	B-1236-E	1934
"	"	1	"	"	"	"	Work Rolls	A- 773-C	1934
"	"	1	20½	32	84	"	" "	A- 417-B	1933
"	"	4	20	48	84	"	Backing Rolls	A-1077-D	1935
"	"	4	"	"	"	"	Work Rolls	B-1472-B	1935
"	"	1	20	36	42	"	Backing Rolls	A- 448-D	1935
"	"	1	"	"	"	"	Work Rolls	B-1472-B	1935
"	"	1	14	49	42	"	Work Rolls	A- 932-J	1935
Hot Strip	4 High	2	16	34	41	American Sheet & Tin Plate Co. Gary, Indiana	Backing Rolls	A- 448-D	1933
"	"	5	"	"	"	"	Work Rolls (Floating)	A-1031-B	1935
"	"	5	"	"	"	"	" " (Thrust End)	A-1032-A	1935
"	"	8	26	53	80	"	Work Rolls	A-1033-B	1935
"	"	6	"	"	"	"	Backing Rolls	A-1034-D	1935
"	2 High	1	36		80	"	Roll Necks	A-1114-B	1935
"	4 High	1	40	54	130	"	Work Rolls	U- 540-B	1935
Cold Strip	4 High	1	16	34	55	American Sheet & Tin Plate Co. McKeesport, Pa.	Backing Rolls	A- 541-D	1934
Cold Strip	2 High	1	8		8	American Steel & Wire Co. Cleveland, Ohio	Roll Necks	A- 312-C	1932
"	"	1	10		10	"	"	A- 313-C	1932
"	"	1	16		24	"	"	A- 314-C	1932
"	"	1	18		32	"	"		
"	4High	1	13½	33	30	"	(Two Per Neck) Backing Rolls	A- 622-C A-1269-B	1934 1936
Tube Elongator		1				Babcock-Wilcox Tube Co. Beaver Falls, Pa.	Disc Rolls	B-1487-A	1936
Cold Strip	2 High	1	8		12	Bopp Steel Corp., Detroit, Mich.	Roll Necks	B-1265-B	1934
Hot Strip	4 High	2	21	45	43	Carnegie Steel Co. Youngstown, Ohio	Backing Rolls	C- 875-C	1935
"	"	4	"	"	"	"	Work Rolls	U- 421-B	1935
Cold Strip	4 High	3	18	42½	42	Carnegie-Illinois Steel Co. Gary, Indiana	Backing Rolls	A- 448-D	1936
							Work Rolls	B-1472-B	1936
Cold Strip	3 High	1	3 7/16	9½	9 11/16	Driver Harris Co. Harrison, New Jersey	Roll Necks (Top and Bottom)	R- 380-A	1936
Hot Strip	Edger	1				Ford Motor Co. Detroit, Michigan	Edger	I- 55-B	1934
Cold Strip	2 High	2	8		8	Greer Steel Co., Dover, Ohio	Roll Necks	B-1418-B	1936
"	"	1	20		22	"	"	B-1486-C	1935
"	4 High	2	13½	30	34	"	Backing Rolls	B-1273-C	1934
"	"	2	"	"	"	"	Work Rolls (Two Per Neck)	B-1384-A	1934
Bar Mill		1	10			Illinois Steel Co. South Chicago, Illinois	Vertical Rolls	I- 312-A	1935
Hot Strip	4 High	6	18	43	38	Illinois Steel Co. Gary, Indiana	Backing Rolls	I- 268-C	1935
"	"	8	"	"	"	"	Work Rolls	C- 661-B	1935
Hot Strip	Edger	1	40 Vertical Edger			Illinois Steel Co. South Chicago, Ill.	Edger	I- 46-C	1931
"	"	1	32 " "			"	Edger	I- 52-B	1931

BANTAM ROLLER BEARING IN STEEL MILLS

during the past two years)

Mill	Type	No. Stands	Roll Sizes Work	Backing	Body	Where Operating	Position of Bearing	Bearing Number	Year Installed
Cold Strip	4 High	1	20	44	72	Inland Steel Co. Indiana Harbor, Indiana	Backing Rolls	I- 321-C	1934
"	"	1	5	33	38		" "	I- 367-C	1936
"	"	1	20	44	54		" "	I- 321-C	1935
"	"	1	"	"	"		Work Rolls	I- 320-C	1935
"	"	1	18	49	42		Backing Rolls	I- 322-C	1935
Hot Strip	4 High	1	11	22	22¾	Laclede Steel Co., Alton, Ill.	Backing Rolls	L- 209-C	1936
Piercing Mill		1	24			National Tube Co. Ellwood City, Pa.	Main Rolls Guide Discs	N- 193-B N- 194-B	1933 1933
Reel Mill		2	24			National Tube Co., Lorain, O.	Roll Necks	N- 239-C	1933
Hot Strip	4 High	1	20	45	72	Otis Steel Co., Cleveland, Ohio	Backing Rolls	O- 242-E	1936
Cold Strip	4 High	1	12	28	30	Otis Steel Co. Cleveland, Ohio	Backing Rolls	O- 261-B	1936
Cold Strip	2 High	2		24	24	Pittsburgh Crucible Steel Midland, Pa.	Roll Necks	B-1573-A	1935
Rod Mill	2 High			20	24	Pittsburgh Crucible Steel Midland, Pa.	Roll Necks	M- 504-Q	1935
Cold Strip	Cluster	1	14	27	54	Republic Steel Corp. Canton, Ohio	Backing Rolls	R- 220-C	1934
"	"	1	"	"	"		" "	R- 270-C	1935
Stainless Cold Strip	4 High	2	15	32	20	Republic Steel Corp. Massillon, Ohio	Backing Rolls	R- 212-E	1932
"	"	2	"	"	"		Work Rolls	R- 100-G	1932
Cold Strip	"	1	9½	24	20		Backing Rolls	R- 305-B	1935
"	"	1	"	"	"		Work Rolls	R- 130-Q	1933
Cold Strip	2 High	1		20	42	Republic Steel Corp. Warren, Ohio	Roll Necks	R- 284-C	1935
"	4 High	1	18	49	42		Work Rolls	R- 271-B	1935
"	"	1	10¼	32	38		" "	U- 266-B	1934
"	"	6	14	32	42		Backing Rolls	R- 179-E	1931
"	"	2	"	"	"		Work Rolls	R- 100-G	1931
Hot Strip	4 High	5	16	32	42	Republic Steel Corp. Warren, Ohio	Backing Rolls	R- 179-E	1931
"	"	5	16	32	42		Work Rolls	R- 144-G	1931
"	Edger	1	Vertical Edger				Edger	I- 55-B	1932
"	"	1	Vertical Edger				Edger	R- 285-A	1932
Cold Strip	4 High	4	18	49	42	Republic Steel Corp. Warren, Ohio	Work Rolls	R- 271-B	1936
"	"	4	"	"	"		Backing Rolls	A-1254-D	1936
Cold Strip	4 High	1	11½	25	18	Rotary Electric Steel Co. Detroit, Michigan	Backing Rolls	B-1290-C	1934
"	2 High	2		12	10		Roll Necks	R- 286-B	1934
Bar Mill	2 High	6		4	4	Rotary Electric Steel Co. Detroit, Michigan	Roll Necks	B-1303-A	1934
"	"	4		5	4		" "	B-1303-A	1934
Cold Strip	2 High	2		8	5½	Seneca Iron & Steel Co. Blasdell, New York	Roll Necks	B-1418-B	1936
Cold Strip	2 High	2		8	5½	Seneca Iron & Steel Co. Fostoria, Ohio	Roll Necks	B-1418-B	1936
Cold Strip	2 High	1		4	4	Stanley Works New Britain, Conn.	Roll Necks	S- 565-A	1934
Cold Strip	4 High	1	13½	30	34	Thomas Steel Co. Warren, Ohio	Backing Rolls	B-1273-C	1934
"	"	1	"	"	"		Work Rolls	B-1384-A	1934
Cold Strip	4 High	1	8	19	16	Universal Steel Co. Bridgeville, Pa.	Backing Rolls	B-1471-A	1935
Cold Strip	2 High	1		14¾ x	18	Wallingford Steel Co. Wallingford, Conn.	Roll Necks	W- 587-B	1936
Hot Strip	2 High	1		27	32	Wheeling Steel Corp. Steubenville, Ohio	Roll Necks	W- 433-A	1935
Cold Strip	4 High	1	20	44	48	Wheeling Steel Corp. Steubenville, Ohio	Backing Rolls	I- 321-C	1936
Cold Strip	2 High	1		27	48	Wheeling Steel Corp. Yorkville, Ohio	Roll Necks	W- 537-C	1935
Cold Strip	4 High	1	16½	49	42	Youngstown Sheet & Tube Co. Indiana Harbor, Indiana	Backing Rolls (Inner Races)	Y- 42-B	1936
		1	"	"	"		Thrust Bearings	U- 670-B	1936
		1	18	49	42		Backing Rolls (Inner Races)	Y- 42-B	1936
		1	"	"	"		Thrust Bearings	U- 670-B	1936

BANTAM

takes pleasure in presenting the foregoing listings which substantiate (without question) statements made by us regarding installations made and service rendered.

It is only through exceptional operating performance that Bantam's position in the steel industry has advanced so rapidly.

Bantam Roller Bearings have proven their ability to roll steel at a lower per ton cost. That, and that alone, is the reason for THE BIG SWING TO BANTAM!

With the new facilities made possible by our second major plant expansion within a year, we are able to take care of more customers who want to avail themselves of Bantam advantages.

Bring your Toughest Bearing job to Bantam.

THE BANTAM BALL BEARING CO.
SOUTH BEND, INDIANA

Normalizing
FURNACE SHAFTS BY *STANDARD*

The Standard method of casting the central section insures uniformity in metal thickness and eliminates machining of the outside diameter of the shaft.

THE three-piece type of shaft pictured above, perfected by Standard engineering research, is delivering most satisfactory results in normalizing furnaces. It eliminates the nuisance and expense of water, as well as the heat losses which water occasions. You reduce the cost of fuel approximately 25%. The bearings far outlast the central shafts and are used repeatedly. There is no machining of the outside tube surface, which insures a uniform thickness of metal throughout the roll. May we have the opportunity of showing you how these and other advantages will benefit your situation? Booklet No. 21 will introduce the subject. . .

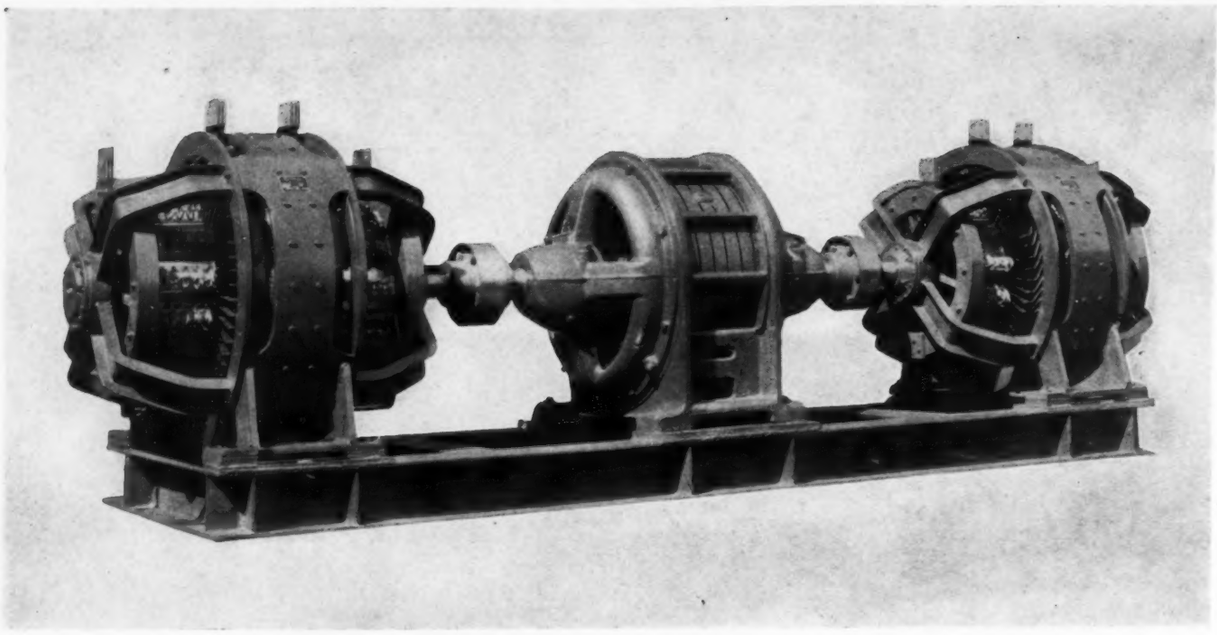
STANDARD ALLOY COMPANY, INC.
1679 COLLAMER ROAD CLEVELAND, OHIO

Standard invites your correspondence relative to the manufacture of high grade heat-resisting alloy castings.

STANDARD ALLOY

TANDARD *Heat-Resisting* CASTINGS

ICKEL CHROME ALLOY



A Modern Low-Voltage Generator that's Built to Take it . . . . . .

TONG TEST AMMETERS

Measure A. C. or D. C. current instantly, accurately, safely and without breaking the circuit. These precision instruments are made to measure up to 800 amperes and are low in price. The Tong Test bulletin describes this faster, better method of current measuring. Would you like a copy?

The more thoroughly you examine Columbia Low-Voltage Generator construction, the easier it is to see why they are chosen so often for strip-plating, electro-cleaning and electro-pickling service.

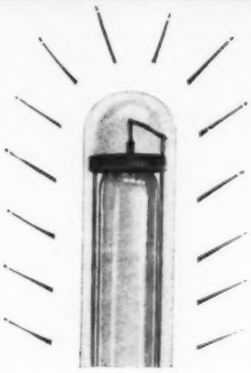
The outstanding performance of these low-voltage generators is based not only on sturdy construction and conservative ratings, but also on the many advanced features of design, which make more efficient operation inevitable. This better performance is being proved daily by numerous installations throughout the steel industry.

Columbia Low-Voltage Generators are built in sizes of 100 to 20,000 amperes. Either synchronous or induction motor generator sets can be furnished. Our generator catalog, which you can read in ten minutes, completely describes Columbia construction. A copy will be mailed you promptly, on request.

COLUMBIA ELECTRIC MFG. CO.
4505 Hamilton Ave. Cleveland, Ohio

COLUMBIA LOW VOLTAGE GENERATORS

FOR HIGH EFFICIENCY MERCURY VAPOR LAMPS



The new mercury vapor lamps give more light per unit of current—reduce electric bills—Jefferson Transformers insure maximum economy.

INSTALL JEFFERSON TRANSFORMERS

Industrial plants, railroads, service stations, large stores—are finding the new high efficiency of mercury vapor lamps an immediate means of improving illumination and cutting electric bills in half.

Jefferson Transformers or Reactors for use with these lamps insure the expected full rated capacity and satisfactory performance. They keep the current demand low during the starting period and on continuous operation show low temperature rise.

A special core has been designed, made up of very thin laminations of high silicon steel, annealed after punching to prevent ageing, and to insure cool operation. Scientific proportions of this core assure proper balance between copper and iron. The windings are machine built and completely insulated with varnished cambric and treated fibres.

Jefferson's long specialized experience in the development of transformers for mercury vapor and Neon luminous tubes, sun lamps, street lights and the like, makes possible the high quality special types of transformers and reactors required to insure the greatest lighting efficiency.

A complete line is available for use with both 250-watt and 400-watt lamps. Write or mail coupon for Bulletin 361-MV and complete data . . . .

Wall Mounted Type in neat metal case for mounting on wall or post. Bottom is open for ready access to wiring compartment. Snap-on connections make it easy to match primary supply line voltage.

(Wall-mounted and fixture types are equipped with primary tap changing device and large primary and secondary wiring compartments.)

Fixture or Suspension Type for mounting between ceiling and lamp—with standard threaded coupling at each end.

Weather-proof Type in one piece drawn steel case—interior compounded. Connections at bottom. Equipped with primary tap changing device.

Core and Coil Type—which fits in fixture. Vacuuized, impregnated with final double varnish dip, bake.

JEFFERSON ELECTRIC COMPANY
BELLWOOD (Suburb of Chicago) ILLINOIS
Canadian Factory: 535 College Street, Toronto

MAIL THE COUPON

JEFFERSON *Mercury Vapor Lamp* Transformers

JEFFERSON ELECTRIC COMPANY,
BELLWOOD, ILLINOIS

Please send Bulletin 361-MV and complete information on Mercury Vapor Lamp Transformers.

Name_____

Address_____

City and State_____

Prevent Short Circuits In Motor Bearings

Ordinary oil, thrown from bearings, soaks windings, causing short circuits. This cannot happen with NON-FLUID OIL—which does not creep or drip—so stays in bearings and off armatures.

Outlasts liquid oil 3 to 5 times, so reduces oil and application cost. Used successfully by thousands of plants.

Send for testing sample today—prepaid—

NO CHARGE.

•

New York & New Jersey Lubricant Co.

Main Office: 292 Madison Ave., New York, N. Y.

WAREHOUSES:

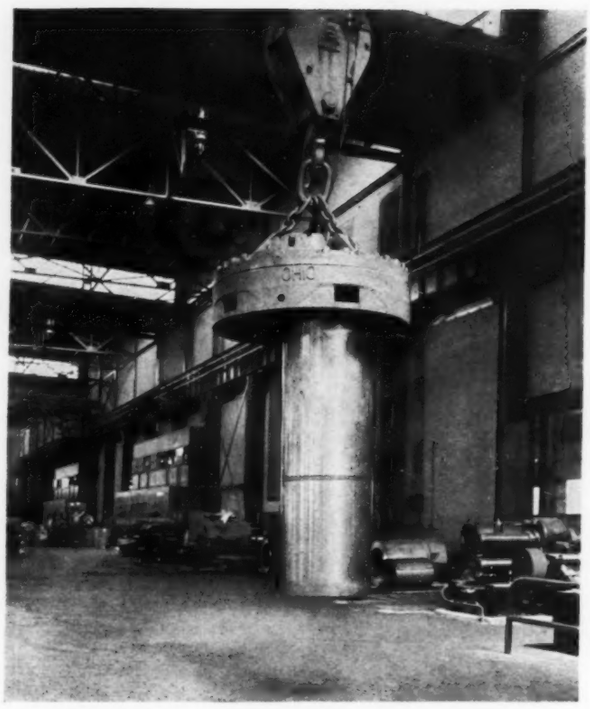
Chicago, Ill.
St. Louis, Mo.
Providence, R. I.
Detroit, Mich.
Spartanburg, S. C.
Atlanta, Ga.
Charlotte, N. C.
Greenville, S. C.

TRADE MARK REGISTERED
NON-FLUID OIL
IN U.S. PAT. OFFICE & FOREIGN COUNTRIES

MODERN STEEL MILL LUBRICANT

Better Lubrication at Less Cost per Month

OHIO



Special Design to lift coils of Strip Steel VERTICALLY.

OHIO LIFTING MAGNETS—Of improved design giving Maximum All Day Lifting Capacity

OHIO SEPARATION MAGNETS—With Stronger Pulling Capacity.

OHIO MAGNET CONTROLLERS—With Automatic Quick Drop to speed up operation and With Ohio Arc Suppressor to reduce the arc and make the Contacts and Arc Shields last much longer.

Ask for new Bulletin No. 109

THE OHIO ELECTRIC MFG. CO.

5907 Maurice Avenue Cleveland, Ohio

Instantaneous action has proved its value in

TAG

Pyrometer Controllers

Increased sales based on superior performance.

Because of these exclusive features:

Instantaneous action at control point.
Highest sensitivity.
No metal pointer; a beam of light instead.
Calibrated accuracy 0.1% of full scale.

TAG Pyrometer Controllers are available in:

2- and 3-Position Indicating Controllers; 2- and 3-Position Recorder-Controllers; Non-hunting, Non-drifting Recorder-Controllers; Multiple Point Recorders; Indicators; Resistance Thermometers; Switches; Thermocouples and Accessories.

If you do not see these instruments at the TAG Booth at the Iron & Steel Exposition, be sure and get your copy of the new TAG Pyrometer Catalog No. 1101-79.

SEE THEM AT BOOTH NO. 38-39

Visit Booth No. 38-39 at the Iron & Steel Exposition at Detroit and see what simple design and sensational performance mean in the complete array of TAG Pyrometer Controllers.

C. J. TAGLIABUE MFG. CO

Park & Nostrand Ave's., Brooklyn, N. Y.

TAG Tagliabue Mfg. Co Brooklyn

MACKINTOSH

. . . for years the *Only* place in America for rolls . . . is still the *Best* place for rolls

Two great rolls foundries, where roll history has been made, and where every basic type of cast roll used anywhere in this country was developed, are busy today turning out Mackintosh-Hemphill rolls . . . a distinct type for every purpose . . . for the ferrous and non-ferrous industries.

Mackintosh-Hemphill has never stopped casting rolls in 113 years. It has never stopped improving rolls. It is still improving them.

Roll Designers today base roll quality on the cost per ton of steel produced...on the *tonnage* rolled as compared with the initial cost of the rolls. The mill performance of Mackintosh-Hemphill rolls has established many of these low-cost standards.

Mackintosh representatives in the field are qualified by experience and training to help you find the right roll for your particular work . . . and the Mackintosh metallurgists and roll experts in the plants are qualified to develop *new* rolls to meet your needs when that is necessary.

Let Mackintosh-Hemphill supply your rolls.

every FIRST in Cast Rolls in 113 Years

In 1823—Mackintosh-Hemphill cast the FIRST chilled iron roll west of the Alleghenies (probably first in U. S.)

In 1843—the FIRST chilled roll for non-ferrous industries.

In 1888—the FIRST Cast Steel Roll.

In 1896—the FIRST nickel steel roll.

In 1908—the FIRST nickel chrome steel roll.

In 1910—the FIRST high carbon steel roll.

In 1913—the FIRST alloy high carbon steel roll.

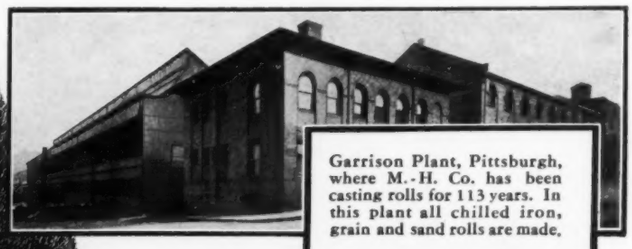
In 1914—the FIRST grain-type roll.

In 1921—the FIRST molybdenum roll.

In 1927—the FIRST nickel chrome hard iron roll.

In 1932—the FIRST anti-firecracking steel roll.

In 1934—the FIRST Nironite-C process roll.



Garrison Plant, Pittsburgh, where M.-H. Co. has been casting rolls for 113 years. In this plant all chilled iron, grain and sand rolls are made.

Midland Plant, Midland, Pa. In this plant all steel and alloy steel rolls are made.

MACKINTOSH-HEMPHILL CO., PITTSBURGH

SINCE 1803

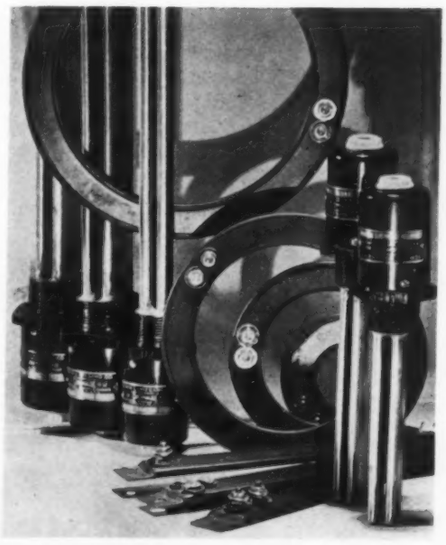
CHROMALOX UNITS *are now heating:*

Rolls . . . Ovens . . . Asphalt Tanks . . . Compound Tanks . . . Melting Pots (babbitt, lead, solder, tin, grease, wax, etc.) . . . Oil and Lubricating Systems . . . Tempering Baths . . . Heaters for drying Transformer Cores and Motors . . . Heaters to keep temperatures above freezing point for Fire Extinguishers, Pipe Lines, Float Switch Chambers, Meters . . . Heaters for remote places such as Crane Cabs, Pump Houses, Sub-Stations, Watchmen's Houses, Oil and Fuel Storage Rooms . . . for occasional use such as First Aid Rooms, or overtime in Offices or Plant Departments.

If it's a job that requires heat, the answer is

CHROMALOX

ELECTRIC HEATING UNITS



Just a few of the many types in which Chromalox Units are built. Whether these units are designed for heating liquids, solids, air, etc., all are constructed on the unique Chromalox principle—a highest grade resistance wire, surrounded by densely compacted and vitrified refractory, which is protected by an outer shell of metal suitable to the service required.

For countless plant executives and engineers, in virtually all industries, the answer has been Chromalox Electric Heating Units for so many heating problems, so widely various in scope, that their complete listing here is beyond praticality.

And every day the list has grown. Every day new uses develop, new ways where Chromalox Units in the broad variety of their types, sizes and capacities, demonstrate their value in improving some process, modernizing the design of some machine, meeting some manufacturer's heating need with gratifying economy and completeness.

Because these problems are in many cases new to designers and engineers, the Edwin L. Wiegand Company maintain an experienced engineering staff to aid in their solution. This cooperation is yours without obligation. Use it.

Bring us your heating problem—an adequate description of the requirements, accompanied by a pencil sketch, is usually all we need. We may be able to indicate savings which will surprise you.

FOR IMMEDIATE REFERENCE keep the Chromalox Book handy. 69 pages of valuable facts and data on electric heat and its application. Send us the coupon below. with your letterhead.

Mail it to-day

See our exhibit at Booth 98, IRON AND STEEL EXPOSITION

EDWIN L. WIEGAND CO.
7545 Thomas Blvd., Pittsburgh, Pa.

☐ **I want to heat..... Attached are sketch and description.**
☐ **Send me the Chromalox Book of Electric Heat.**

Name .....

Position .....

Rollway

Maximum

Performance

In that field for which straight roller radial and thrust bearings are better fitted than any other type, Rollway has concentrated its experience and facilities, developed bearings to—take maximum loads at a given speed, sustain maximum speeds for a given size, and effect maximum economy in bearing size and operation.

Trite? Yes, but these objectives have necessitated continuous development or application of new designs and materials, improved processes, and strenuous tests.

We should like to serve you with these tools of accumulated experience. A catalog for you at your request.

You will find Rollway bearings at Booth No. 191.

ROLLWAY BEARING
COMPANY INCORPORATED
SYRACUSE NEW YORK

ROLLWAY
CYLINDRICAL ROLLER
BEARINGS

Excuse us, please

OUR PLANT,—JULY 30th

WE ARE sorry that we are not to be listed among the exhibitors at the Iron and Steel Exposition in Detroit this month but—

—During our yearly vacation-week shut-down when only a skeleton force was on hand, fire broke out in our paint spraying department and almost immediately flared out into a 5-alarm conflagration destroying practically our entire stock room.

The fire happened on the morning of Thursday, July 30. Due entirely to the loyalty and efforts of our employees, by Monday morning, wheels were again turning and we are now filling orders in our usual prompt manner.

We appreciate greatly the forbearance of our customers during the first few weeks of this trying period.

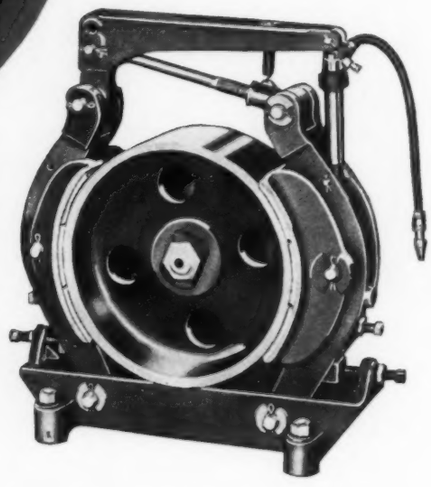
ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.

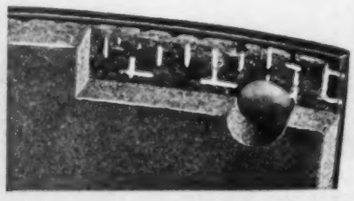
NO SCORING
LONGER BRAKE LIFE
PRE-FORMED LINING
LOWER MAINTENANCE

FOR DEPENDABLE SERVICE USE Wagner CoMaX BRAKE LINING

Wagner CoMaX industrial-brake blocks are available in every form and dimension used in the steel industry—to fit every type and make of industrial brake. Above photo shows Wagner CoMaX industrial lining mounted on brake shoe. Especially note the thickness of the lining and the depth of the rivet holes—assuring longer lining life and lower maintenance.



The illustration to the right shows a close-up view of the hydraulic brake and brake shoes used in a large steel plant. The brake shoes are lined with CoMaX lining.



Note the deep-seated rivet in this cut-away section. Wagner CoMaX can be counter-bored down to the strong wire backing, to seat the rivets directly on the wire. Thus the amount of lining available for braking service is considerably increased, permitting longer service for equal lining thickness than that available with other types of lining. For example, in a Wagner CoMaX block ½-inch in thickness, the rivets can be seated to within 1/16-inch for wear before the rivet-heads touch the brake-wheel. In other words, as much as 87½% of the material in ½-inch lining is available for braking service.

Visit WAGNER BOOTHS No. 179-180 Iron & Steel Exposition Detroit, Mich. Sept. 22-25

WAGNER CoMaX brake lining is pre-formed in blocks to fit all types and makes of industrial brakes. The blocks save installation time and reduce inventory.

Wagner CoMaX is non-abrasive—hence, wherever installed, scoring of brake wheels is a matter of the past. Wagner CoMaX is exceptionally long-lived—cuts down maintenance, lowers overhead, lessens shutdowns for replacement of brake-wheels and brake lining.

Each CoMaX block is ground on both sides, assuring perfect overall contact between lining and brake wheel. The blocks are wire-backed, permitting deep seating of rivets and increasing the depth of lining available for braking service.

B-336-1

AUTOMOTIVE PARTS DIVISION

Wagner Electric Corporation
6400 Plymouth Avenue, Saint Louis, U.S.A.

● Viscosity may be broken down into two characteristics—adhesive and cohesive forces of, and between, oil particles.

In all lubrication problems, the adhesive and cohesive characteristics of the lubricant must be nicely balanced to meet each case.

This is especially true in gear lubrication when the "squeezing out" forces, acting on the lubricant, may assume high values. The adhesive force—which under exceptionally high pressures, or very low speeds, may cause the lubricant to act only as an anti-flux—builds a foundation for the secondary layers or films of lubricant which, due to their cohesive forces, permits the combination to act as a true lubricant to better resist the "squeezing out" action.

Pure's PURELUBE has within it the "ounce of prevention"—that small quantity of meticulously made base which increases the two forces in just the proper relationship.

Ask a Pure Oil lubrication engineer to call and discuss your extreme-pressure lubrication problem with you.

Comprising Pure Oil's Three Point Service is: 1. Selected Crude. 2. Skillful Refining and 3. Scientific Application.

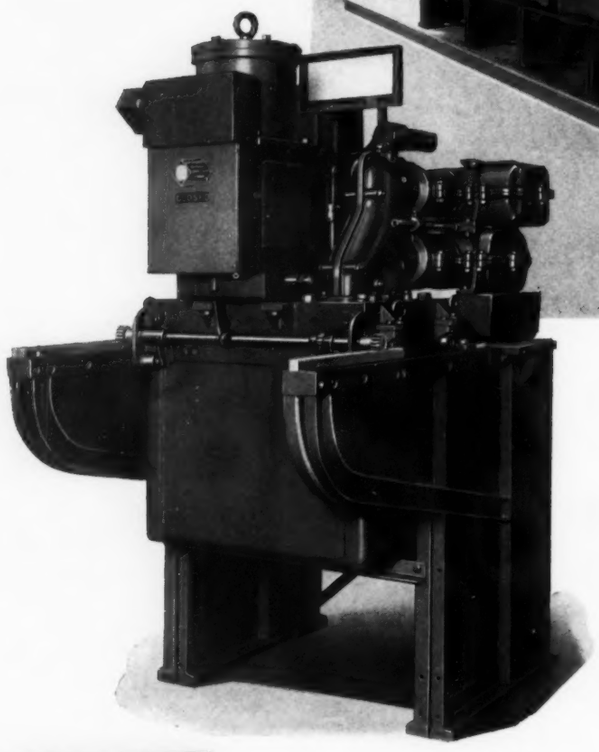
THE PURE OIL CO.

U. S. A.

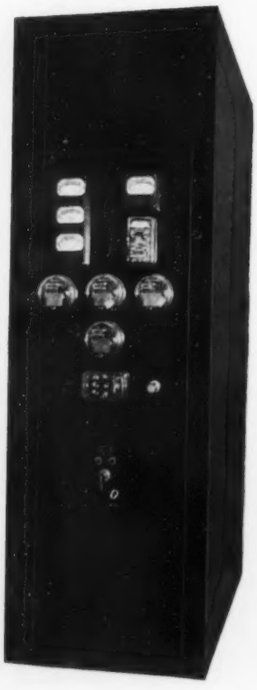
PRODUCERS, REFINERS, MARKETERS OF A COMPLETE LINE OF PETROLEUM PRODUCTS

Six 15000 volt, 700 amp. 3-phase, 25 cycle Armorclad Switchgear units, 250,000 kva rupturing capacity feeding 1000 kw and 5000 kw m-g sets.

This is an installation view in a modern steel mill.



Safety Switchgear *for* Steel Mills



ALLIS-CHALMERS steel mill switchgear furnishes the ultimate in safety to operators and protective features for equipment.

Armorclad switchgear totally enclosed, compound filled, with complete interlock or cubical type switchgear is especially designed for steel mill service.

SWITCHGEAR DIVISION

ALLIS·CHALMERS

MILWAUKEE WISCONSIN

ON DISPLAY FOR THE FIRST TIME AT THE DETROIT SHOW

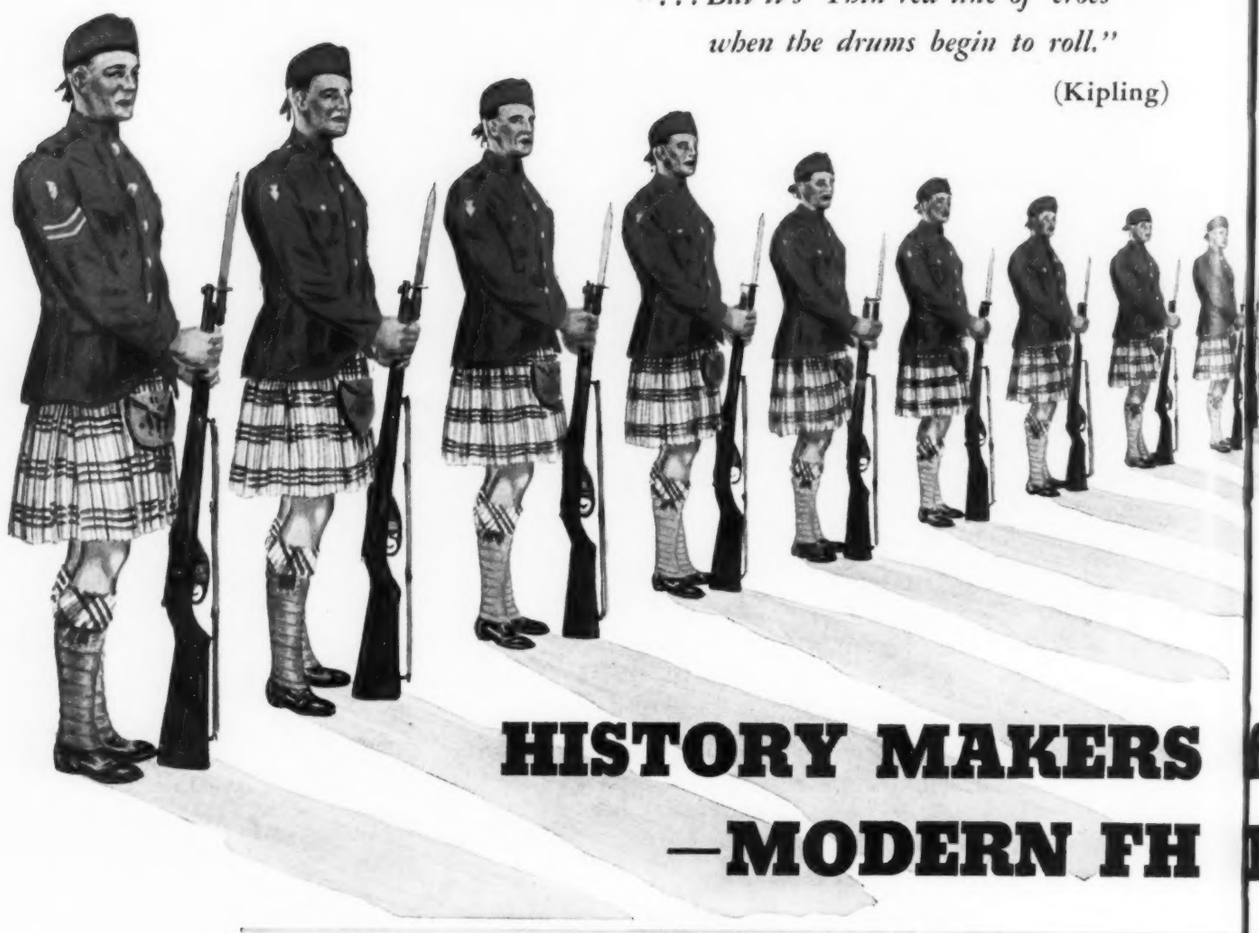
A new development in automatic filters of smaller capacities (under 20,000 C.F.M.)

Complementing the famous-

Multi-Panel AUTOMATIC

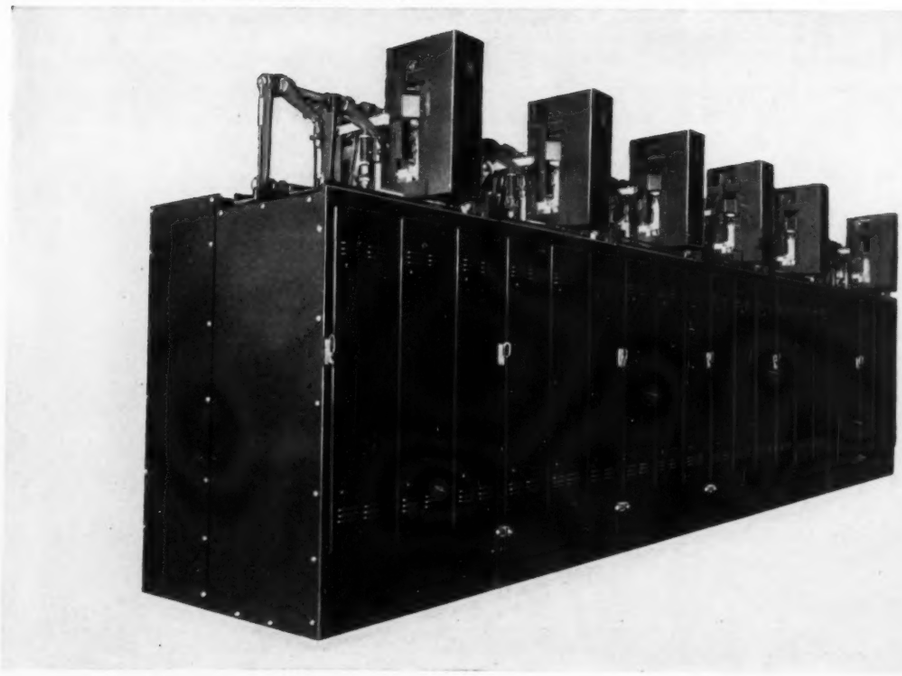
VISIT THE AMERICAN AIR FILTER CO. BOOTH No. 153 AT THE IRON AND STEEL EXPOSITION, DETROIT.

"... But it's 'Thin red line of 'eroes'
when the drums begin to roll."
(Kipling)

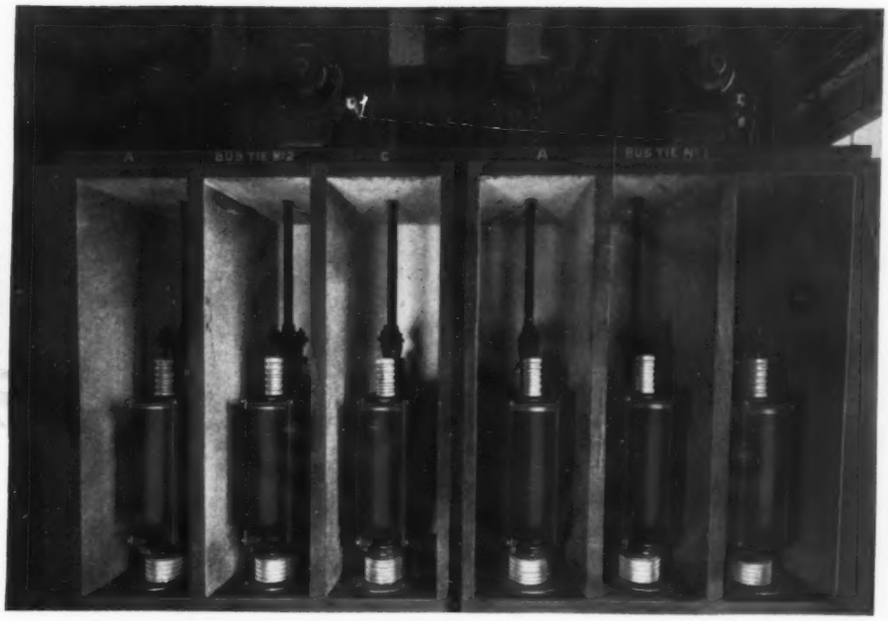


HISTORY MAKERS —MODERN FH

G.E. BUILDS WITH STEEL



G E N E R A L



for PROTECTION and ECONOMY
BREAKERS MARCH ON in STEEL

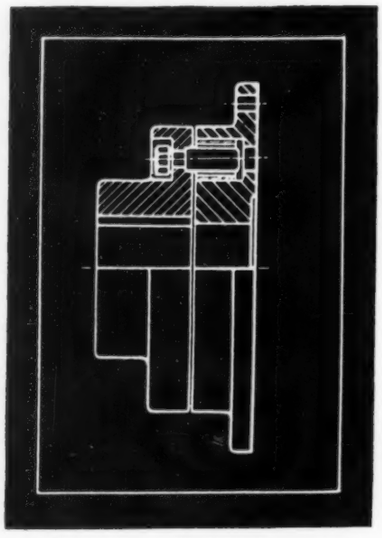
STEEL MEN recognize in the success of more than 30,000 FH breakers in front-line duty—many of them since 1898—the soundness of the basic FH principle—eloquent proof of their dependability.

Today these breakers are housed in steel cubicles or trucks with sturdy interlocks to assure the utmost in safety to personnel and equipment. Furthermore, you receive these units assembled—ready for immediate low-cost installation. General Electric Company, Schenectady, New York.

890-6

ELECTRIC

Special Couplings



In the field of specialized coupling installation, Ajax is the acknowledged leader—maintaining a staff of engineers who have successfully solved so many special coupling problems that today there is an Ajax Flexible Coupling for almost every specialized need. New developments are going forward daily. . . . Above is shown a simple adaptation for connecting internal combustion engines to electric generators—here made so that one flange can be bolted directly to the engine flywheel. All bushings are mounted in the flywheel half of the coupling and all the studs in the standard half. Note the slight recess in the special flange which serves as a pilot.

AJAX

FLEXIBLE COUPLING CO.

42 ENGLISH STREET

WESTFIELD, N. Y.

SALES OFFICES

Atlanta, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Detroit, Fort Worth, Indianapolis, Los Angeles, Minneapolis, Montreal, New York City, Philadelphia, Pittsburgh, St. Louis, San Antonio, San Francisco, Syracuse.

ROCKBESTOS CIRCUITS *can be run* STRAIGHT

There are no detours around steam pipes, boilers, furnaces or other hot spots when circuits are wired with Rockbestos.

Heat dries out ordinary insulation . . . it becomes brittle, cracks, flakes, disintegrates . . . and then it's a set-up for failure. Rockbestos insulation is basically asbestos—a mineral, but non-metallic. Highly resistant to heat and other insulation destroyers, it withstands deterioration—it's a *permanent insulation.*

By using Rockbestos you can forget heat, moisture, oil, grease, vibration and the other enemies of insulation . . . make installations simple and easier . . . and use *less* wire.

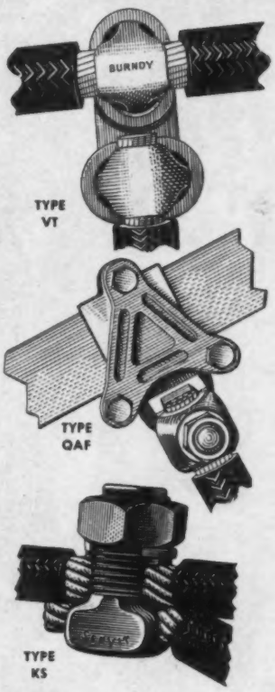
There are over 50 wire constructions in the Rockbestos line, designed to meet all sorts of severe operating conditions. Tell us your requirements and we will make recommendations and send a sample—no obligation. Rockbestos Products Corporation, 825 Nicoll St., New Haven, Conn.

Visit us at the Iron & Steel Exposition. We'll be in Booth 43 with something new in exhibits.

ROCKBESTOS A.V.C.

the wire with permanent insulation

Specify BURNDY
FOR EVERY ELECTRICAL CONNECTION



Wherever electrical conductors are joined, there is a BURNDY CONNECTOR to do the job—faster, more efficiently, with greater economy. Connect with Burndy on your next job. If you do not have Catalog 33C, write for a copy.

Type VT. A compact T-connector for any size of wire or cable, and for any combination of run and tap diameters. The forged U-bolt clamping element permits a wide range of cables to be used.

Type QAF. A flat bar to cable T-connector which eliminates drilling holes in the bar. Will withstand vibration, strain, or overload. Made for any combination of flat bar to cable.

Type KS. The Servit is manufactured by a patented forging process which gives it unequalled strength and toughness. Will not fail as a result of overload or vibration. Made in all sizes to 1000 Mcm.

Type QA. The Qiklug eliminates solder, and substitutes speed, economy, safety. Requires no more space on panel than solder type lug. Installed by tightening a single nut.

Type FE. For connecting a cable to flat bar either on end or at a right angle. Can also be used to connect flat bar to tubular bus. Supplied with Everdur bolts, nuts, and lockwashers.

Type PG. The Tapit consists of a copper core molded into and insulated by a canvas-Bakelite jacket. Tightening the bolts forces the conductors into contact, and securely insulates the joint.

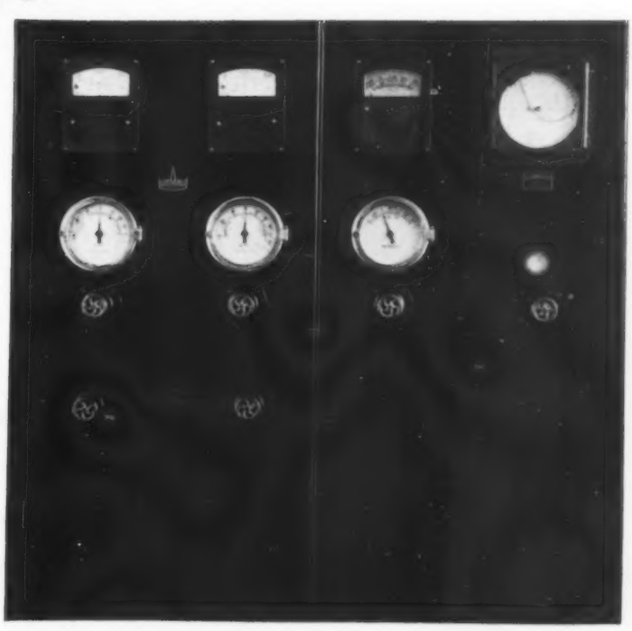
BURNDY
ENGINEERING COMPANY, Inc.
305 EAST 45th STREET · NEW YORK

ASKANIA
CHICAGO

Atmosphere Control

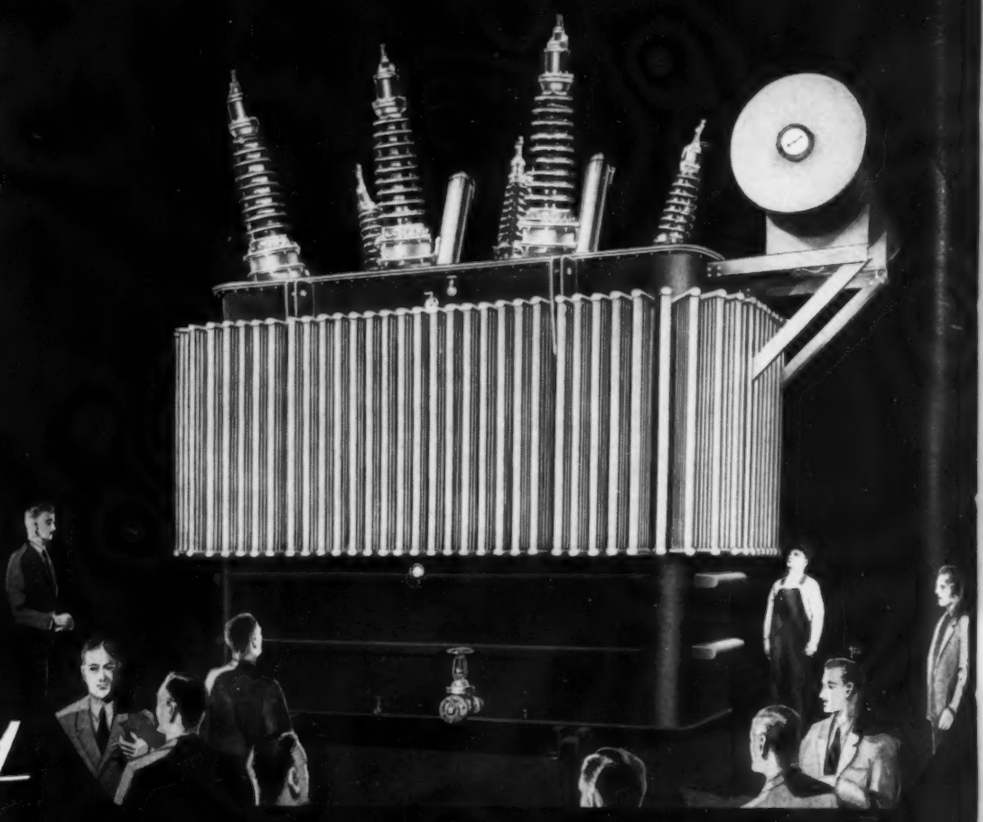
- DRAFT
- COMBUSTION
- FUEL FLOW

Ask for Bulletins No. 100 & 104



ASKANIA REGULATOR CO.
1603 SOUTH MICHIGAN AVE. - CHICAGO

PENNSYLVANIA
TRANSFORMERS



Before you buy

Ask these questions...

Pennsylvania answers "Yes"

PENNSYLVANIA TRANSFORMER CO · · PITTSBURGH, PA.